THE

True Theory and Practice

OF

HUSBANDRY:

DEDUCED FROM

Philoſophical Reſearches, and *Experience*.

To which is annexed, (illuſtrated with COPPER-PLATES)

A Compendium of MECHANICS:

Calculated to aſſiſt

The *Huſbandman* in the Choice and Conſtruction of every IMPLEMENT peculiar to his Buſineſs:

AND

Others particularly uſeful in a commercial Country.

By CUTHBERT CLARKE.

LONDON:

Printed for the AUTHOR; and ſold by G. ROBINSON, in Paternoſter-Row; and T. SLACK, in Newcaſtle.

MDCCLXXVII.



DEDICATION.

TO THE

Proprietors and Occupiers of Land,

IN

GREAT-BRITAIN.

GENTLEMEN,

AS *every judicious company, that have opened a new ſource of trade, would think it their duty to ſolicit the particular attention of thoſe who were the beſt judges of their wares, and moſt likely to become their cuſtomers: So, in like manner, muſt* Authors *ſee it their indiſpenſable duty to dedicate their performances to thoſe who are moſt intereſted in the Arts or Sciences upon which* they *treat.*

THIS *being the caſe,* Gentlemen, *permit me, with the moſt profound reſpect and utmoſt deference, to ſolicit your attention and patronage to this performance, which contains my beſt endeavours to be uſeful to mankind, by reſolving the hitherto random Art of Huſbandry into a* SCIENCE; *and, I hope, with propriety and clearneſs; pointing out to the huſbandman, what, at all times, is beſt to be done in the courſe of his buſineſs.*

YOU *may indeed very juſtly with-hold the protection I now take the liberty to ſolicit, until you are convinced by experience that I deſerve it: Yet in the interim, I hope I may ſo far engage your candour and kind indulgence, as not to condemn it haſtily:—*

FOR *as it contains many things that have not hitherto been laid before the public; their novelty, and the poor, tho' beſt, dreſs I have been able to give them, may give diſguſt: Altho' when they become better known, they will, I doubt not, meet with chearful acceptance.*

NAY, *the very title of the book, perhaps, may offend ſome; nothing being eſteemed more unneceſſary to huſbandry, by meer practitioners in that art, than* Theory: *But this idea, after this performance has been carefully peruſed, will, I hope, have no more credit with the reader, than it has exiſtence in fact. And with as great propriety may the mere druggiſt ſet up for phyſician, or the bellows-blower for organiſt, as a mere practitioner in huſbandry preſume to manage as well, (eſpecially in exigencies) as a perſon that has a competent knowledge of both* Theory and Practice; *every other thing being equal.*

IT *will alſo, I doubt not, be alledged by many, that books on huſbandry are already more plentiful than uſeful. To which opinion I do readily accord*; but I am willing to hope, that thoſe who peruſe this performance with attention, will reap more advantage even from*

* NOT ſo much on account of their uſeleſneſs, as their not being put to uſe.

from books *than they have hitherto been able to do; becauſe it may be applied as a ſarcenet, to ſeparate* their *honey from* the *wax.*

THE *method I have adopted to convey my thoughts, may alſo be objected to, in as much as it unavoidably occaſions diſquiſition foreign to the ſubject. But, I hope, thoſe who are at the trouble to make this objection, will alſo pleaſe to obſerve, that as often as any thing of this kind has occurred in the work, it has a tendency either to enliven the diſcourſe, or correct the behaviour of the interlocutors. The method, on every other account, I humbly preſume, will be thought eligible, as all manner of objections and queſtions that have been put, are anſwered with more familiarity and clearneſs, than they could have been in the narrative diction.*

I MAY *alſo reaſonably expect many of my ſubſcribers will be not a little offended at my tedious delay in compleating the work, as I have been favoured with their names upwards of three years.—To ſuch I cannot offer a better apology than the following facts:*—Between three and four years ago I put the work to preſs, and in a few months had more than half of it printed: I then thought it high time to impart my deſign to the public, and receive their orders. However, in a little time, I had the offer of *(ſeemingly)* an advantageous employment, which I accepted, not doubting that I ſhould be able ſtill to complete the work as propoſed; but was ſoon convinced, that the duties of my office, and a proper

per attention to the preſs, were almoſt totally incompatible: From which circumſtances it is, that what might have been completed in ſix months, has laid in hand above three years.

LASTLY, *As every perſon that* WILL *criticiſe has it in his power to detect errors, as well on my part as on the part of the preſs, I have a right to expect the rod will be raiſed againſt me. In this ſituation, little, very little indeed, can I with propriety advance to avert the ſtroke! Yet I hope to ſurvive it; ſince every critic worth notice, muſt have more pleaſure, and think it more his buſineſs, as a friend to the public,* in holding up even one found ſpot in an Author, *than* probing his numerous ſores; *and becauſe I am conſcious I had the public good at heart, and have deduced my* Theory of Huſbandry, *and the other parts of the work, from proper reſources.*

HAVING *thus troubled you,* GENTLEMEN, *with a partial detail of what, probably, may be urged againſt this performance; and alſo with what I humbly hope will be allowed to plead as an apology for ſuch defects; I think it my duty, in the next place, to offer to your conſideration certain facts, in which you are yourſelves very deeply intereſted.*

Now, as it has been proved beyond diſpute, that land is only the receptacle of the food of plants, and not the real food itſelf, it behoves every proprietor of land to take the utmoſt care that his land

land is not unfairly ſtripped of its treaſure: For if land is reduced to ſo low an ebb, that the occupiers cannot reap more than fifteen (Wincheſter) buſhels of wheat, and twenty of peas; or fifteen of wheat, and twenty-five of oats per acre, from a two crop fallow; it is impoſſible, at the preſent prices of grain, (and they are not bad ones) that he can pay either tithe or rent for ſuch land.

THIS, *tho' an uncommon aſſertion*, GENTLEMEN, *is moſt certainly a juſt one! And when we recollect how common a caſe this ſhort produce is, and that it is ſtill growing more ſo*, not only the LEGISLATURE, but the community at large have reaſon to be alarmed! For ſhould all land be reduced to this ſtate, and experience as well as theory evince it poſſible, there could ariſe neither bread to the occupiers, rent to the owner, relief to the poor, nor tax to the KING: Whereas if eſtates are kept in heart, they will yield plenty to them all.

NOTHING *can be more intereſting, therefore, to landed men, to occupiers of land, and indeed to the public in general, than a careful obſervance of the means which will inſure the latter, and prevent the former?*

THAT *I have pointed out the real means to improve land of every complexion, and likewiſe how they may be procured and applied at the*

the moſt reaſonable rates, I have the happineſs to think will, 'ere long, be generally allowed: And that ſucceſs may attend every attempt to elucidate a profeſſion that has in the wiſeſt and beſt of times (from the earlieſt antiquity to the preſent period) been held in the higheſt eſteem, is the ſincere wiſh, and ardent deſire of,

GENTLEMEN,

Your moſt obedient,

DURHAM,
Aug. 1777.

And faithful Servant,

C. CLARKE.

THE CONTENTS.

SECT. I.

Page.

THE neceſſity of a theory of huſbandry demonſtrated, in a ſeries of diſcourſes, between PHILOSOPHUS and AGRICOLA — 1
A plan of education for youth deſigned for huſbandry — — 18
The form of a weekly bill of the buſineſs and expence of a farm — 22
An eaſy method of book-keeping ——— ——— 26
The neceſſity of farmers making entries of their tranſactions — 32
Some neceſſary precedents ——— ——— — 34
Who are, and who are not fit for huſbandmen ——— — 40
The criterion of good plowing ſhewn ——— — 43
The abſurdity of deciding matters of ſcience by jokes, pointed out 47
Obſervations on thin plowing, &c. ——— — 48
Experiments to ſhew how corn vegetates ——— — 55
The affinity between plants and animals pointed out — — 57
Reflections thereon ———— ——— ——— 61
Experiments to ſhew the depth and diſtance that ſeed-corn ſhould be depoſited at, to ſucceed the beſt ——— ——— 63
The way to make wheat in the leaf keep or recover its verdure, &c. 75
The beſt form of ridges pointed out ——— ——— 82
The joint uſe of plowing and manure recommended ——— 84
Further explanation of the nature and uſe of ſoil ——— 85
What the real food of plants is ——— ——— 86
A proof that Nature cannot be diſſolved without a ſuſpenſion of its laws ——— ——— ——— — 87
A common error in huſbandry pointed out ——— — 89
The remedy pointed out ——— ——— — 90
The uſe and abuſe of liming land ——— — 92
Select matters in the buſineſs of huſbandmen pointed out — 94
A note, explaining the nature of lime ——— — 95

Page.

Analogy between ſoil and the animal ſtomach — 97
Animal and vegetable re-production a ſubſtitute for creation — 99
The uſe of inſtinct amongſt animals, &c. — 100
The neceſſity of huſbandmen being judges of ſtock urged — 104
The true ſhape of a horſe — 105
The true ſhape of a bull, &c. — 108
The abſurdity of croſſing in the breed of cattle, pointed out — 111
The true ſhape of a ram, &c. — 115
Of the different breeds of ſheep — 117
The cauſe of the rot or decay amongſt ſheep, and its remedy — 119
The different breeds of ſwine, their comparative excellence, &c. 125
The beſt method of chooſing and preſerving ſeeds — 134
The cauſe and remedy of the ſmut or ſlay in wheat — 136
The beſt ſteeps for ſeed pointed out — 140
Change of ſeed corn recommended, and why — 142
The leaſt weight that ſeed-corn ſhould be taken at, minutely pointed out — 143
The reaſon of corn degenerating pointed out — 145
Recapitulation of the particulars relative to ſeeds — 147
AGRICOLA put upon his behaviour — 148
Exordium to the diſſertation on graſſes — 149
A new theory of abſorption, &c. — 151
A practicable method of improving land by this theory — 163
The time to harveſt graſſes for ſeed pointed out — 165
The time and manner of making good hay ſhewn — 166
The preparation of ſoils for graſſes of different ſorts — 170
A cheap and effectual artificial manure pointed out — 172
Its attractive quality demonſtrated — 174
The beſt way to improve land ſown with ray-graſs — 175
Reaſons for omiting a crop of corn when graſs-ſeeds are ſown — 177
Remarks on ſtinting new land, &c. — 179
On the propriety of changing land — 181
The beſt graſſes for ſheep-paſture, &c. — 184
Theory further illuſtrated — 185
Seeds improper for pleaſure-ground pointed out — 186
Precautions relative to draining land — 187
Directions to reclaim poor land — 188
The rationale of turnip culture — 191

An

Page.

An effectual method of deſtroying the turnip fly ——— --- 192
Further account of turnip-culture, and what is the beſt ſeed --- 197
The neceſſity of good harrowing demonſtrated ——— 202
How to manage lands that have been pared and burnt ——— 203
The waſte of manure by field foddering pointed out ——— 204
The utility of low-ſhearing corn ſhewn —— —— 205
The uſe of water as a manure —— —— — 206
Beſt graſſes for flooded land pointed out —— —— 212
Beſt way to uſe watered land pointed out —— — 213
Culture of lucern —— —— —— — 214
Culture of ſaint-foin —— —— — —— 218
Culture of burnet ——— —— ——— —— 221
Culture and uſe of red clover — —— ——— 224
Red clover taken in lieu of oats recommended - —— 229
Rationale of planting - —— ——— 231
Remarks on pruning — —— —— 235
The way to raiſe and preſerve good live fences — — 237
The beſt directions of fences to give ſhelter -- ——— 242
The cauſe of pinching winds in the Spring, and ſhaking winds in Autumn, accounted for upon a new principle -- —— 243
An impartial method of valuing and letting land ——— 246
The form of the courſe of huſbandry, and leaſe of a farm —— 253
Neceſſary particulars to be obſerved in taking a farm —— 260
The converſation uſual on taking farms —— —— 265
Proper form of an agreement for a farm ——— — 267
Specimen of a good landlord —— —— —— 268

SECT. II.

THE uſe of mechanics ——— ——— 277
Lever of the firſt kind explained ——— - 278
Skrew explained ——— —— —— 280
The wheel and axis explained —— —— 281
Levers of the ſecond and third kind explained —— --- 285
The balance conſidered and improved ——— —— 286

Page.

A loſs to ſellers and buyers avoided by a particular conſtruction of the ſcales —— —— —— 290
Data for an univerſal and invariable ſtandard of weights and meaſures —— —— —— 292
The attraction of coheſion provided againſt —— -- 293
The elaſticity of bodies provided againſt —— —— 302
Ditto, its uſefulneſs, and how to apply it properly —— 306
The preſſure and impulſe of fluids provided againſt - 313
Ditto, their uſefulneſs, and how to apply them properly to mills, &c. 319
The beſt figure of a building to reſiſt wind, &c. illuſtrated in a building for conveying off lightening, &c. —— —— 322
The proper form of a conductor for that purpoſe —— 323
The theory of ſwimming and ſinking —— —— 324
The beſt way to annihilate friction —— —— 326
The uſe of friction, and coheſion in maſonry, proved by a proper mode of preparing mortar or bitumen —— — 328

SECT. III.

DESCRIPTION of inſtruments, viz. two drain plows --- 332
Deſcription of a trenching and paring plow —— 335
Deſcription of a turn-wriſt plow —— —— 342
Account of the beſt kind of burnet —— --- 345
Deſcription of a curious drill plow —— —— *ib.*
Deſcription of a plow that may be drawn with the leaſt force poſſible —— —— —— 347
The doctrine of wheel carriages —— —— 351
Explanation of a mill or machine for threſhing corn —— 358

THEORY

THEORY OF HUSBANDRY.

SECT. I.

CONVERSATION I.

The Neceſſity of THEORY *demonſtrated, in a Series of familiar Diſcourſes between a candid Philoſopher and an intelligent Huſbandman.*

AGRICOLA.

SIR, the debate laſt night between you and the gentlemen, relative to the neceſſity of theory in the ſcience of medicine, ended ſo entirely in your favour, that I am come thus early in the evening to be informed, (if you pleaſe to favour me) whether Huſbandry lies under a ſimilar neceſſity of theory: and if ſo, that you will aſſiſt me in attaining a rational one.

Philoſophus. THE debate you mention ended undoubtedly in favour of Theory; and I am happy in the victory, as truth proved triumphant over error: but no man has a right to purſue or enjoy victory gained by dint of argument, or any other means, further than it tends to exterminate error, and ſecure his indemnification. And as to your requeſts, ſo far as I am able to anſwer them, they ſhall be complied with. It gives me peculiar ſatisfaction to behold a fellow-labourer in the field of ſcience ſo frankly ſolicitous of information. The man who thus honeſtly unfolds his wiſh without prevarication, at once becomes endearing; and nothing that ſuch an ingenuous mind is capable of aſking, ſhould be refuſed: whereas the requeſt of the double-dealer and buffoon ought ever to be deſpiſed. And ſuffice it now, my worthy *Agricola*, to be premiſed, that in our conferences no unneceſſary ceremony or reſtraint be introduced or regarded on either ſide.

Agric. Agreed: the propoſal is really to my advantage; for in conſideration of aſking freely, what I have the moſt immoderate deſire to be honeſtly informed of, will be generouſly explained to me, in a manner ſuitable to my capacity.

Phil. I KNOW you too well to ſuſpect you guilty of thinking me deficient either in point of integrity, generoſity, or perſpicuity. Nor can I entertain the leaſt ſuſpicion of you having an intention to flatter. I know thoſe remarks you have made are the ſentiments of honeſt ſimplicity, and therefore deſerve not to be conſtrued as liberties taken, nor pretext for any riſible emotion.

YOUR deſire of being honeſtly informed in a matter of that importance, or indeed of any matter, is neither rude nor injudicious. The fate of *Viator*, who unfortunately ſolicited direction from *Perfidia*, relative to his road, (who ſent him over a wrong path, where he wandered ſo long, that through fatigue, hunger, and deſpair, he fainted, and never attained the end of his journey) is a ſufficient apology for that. This ought to be a light-houſe

to

to every enquirer; and the juſt odium which devolved on *Perfidia*, ought to be the dread of all inſtructors, leſt by oſtentation or fallacy, they become *Perfidias*. Your deſire, *Agricola*, that the intended information be conveyed to you in a ſtile ſuitable to your capacity, is alſo every way pertinent. Certainly no behaviour can be more ungenteel than uttering a parade of unintelligible accents to a pupil: it muſt give offence to every ingenuous mind, and unſufferably embarraſs and perplex the moſt candid enquirer. There is, no doubt, a warrantable plea for keeping to a decent ſtile; and in ſcience, a few terms peculiar thereto cannot be avoided. But even thoſe, with the aſſiſtance of the little vocabulary* I put into your hands, (ſome time ago) to you will be quite familiar and eaſy.

Agric. I HAVE carefully peruſed it, Sir, and believe I underſtand every explanation therein; and ſhall be able ever to retain them.

Phil. SUCH diligence and reſolution will do, *Agricola*.—It is pleaſure to inſtruct diligent and anxious pupils; to them there is nothing impoſſible. On the other hand, the negligent and irreſolute are ever at a loſs. The cleareſt facts appear with them dubious and intricate; and every particle of inſtruction has an irkſome idea annexed. Hence we take no ſurpriſe when we hear learning ſometimes made the butt of ridicule, becauſe we are ſure none but the negligent and totally malevolent are capable of ſuch abuſes.

AND now let me proceed to anſwer your firſt enquiry; namely, Whether huſbandry lies under an equal neceſſity of theory which the profeſſions *Empiricus* and I were mentioning, did? But as it would be too laconic barely to tell you it doth, and without farther explanation might be inſufficient to produce conviction, I ſhall therefore be glad you would chuſe any of them as a contraſt.

* Meaning that at the end of this work.

Agric. THE propoſal is exceedingly fair; and as I wiſh to find practical huſbandry exempt from ſuch an imputation as being incomplete without theory, I ſhall certainly chuſe one of the profeſſions to be oppoſed to it, which you have already convinced me is, without theory, extremely deficient, and uncertain of ſucceſs; and of thoſe, I think none more to my purpoſe than phyſic. I ſhall be greatly ſurpriſed indeed, if at any rate huſbandmen have the ſame occaſion for theory which phyſicians have. If ſo, neighbour *Ruſtico*, and all of us who intend our ſons for huſbandmen, ſhould ſend them to college, not to enure them to labour, I own, but to learn the-o-ry. I proteſt, Sir, I am not a little diverted when I think what nice flippant plowmen our collegians will be.

Phil. WITH all my heart, *Agricola*; enjoy it or the tankard, which you pleaſe, but I recommend the latter, whilſt I ſtep to *Soror*, and take one cup of ground-ivy.

- -

Now, *Agricola*, you have enjoyed the thought I dare ſay:—and ſo have I too, I aſſure you, but not to your diſadvantage; for ſuch point-blank repartee gives me the ſtrongeſt aſſurance that you have a laudable degree of tenacity; or, according to the common phraſe, that you are not one of thoſe who will ſuffer their teeth to be drawn, unleſs they know for what. A victory gained on you, *Agricola*, will give me more ſatisfaction than if gained on a thouſand ſervile pedants, who tamely ſtrike without oppoſition.

BUT to our purpoſe—So you have choſen the ſcience of medicine, as the moſt dependant on theory of any you know; and incomparably more ſo, you think, than huſbandry. It is right, undoubtedly, that phyſic can only be warrantably practiſed by men who have ſtudied anatomy, and the nature of medicine;

as

as thereby they acquire the thorough knowledge of the ſeats and cauſes of diſorders, their tendencies, and the virtues of thoſe ſimples or drugs moſt likely to abate their malignancy, and reſtore health and ſoundneſs to the body. And this is what is meant in that profeſſion by the word *Theory*. Indeed theory in any profeſſion or ſcience, ſignifies neither more nor leſs than a fore-knowledge of the effects that will be produced by a given proceſs on ſubjects, whoſe properties the theoriſt is intimately acquainted with.

Agric. I HEARTILY accord to the theory of phyſic, as it is infinitely preferable to preſcribing at random; becauſe, without a fore-knowledge of the nature of the potion and diſorder, the odds are greatly that the preſcription will do more ill than good. I really ſhudder at the thoughts of ſo dangerous a procedure, and ſincerely wiſh, for the good of mankind, that none were allowed to practiſe in phyſic, but ſuch as have had thorough preparation.

Phil. YOU certainly are right, *Agricola*: It is, indeed, much to be lamented that empirics ſhould be let looſe on the public, and ſuffered to practiſe upon the health of the unwary and credulous, as they do at preſent. But would you think now! that if it were not for the preference due to the objects which empirics in phyſic practiſe upon, to the objects thoſe who practiſe huſbandry without theory are in purſuit of, that there would not be a ſcruple of difference in their reſpective criminalities.

Agric. IT is now to a minute the time I appointed to be with *Serva*, to contrive to-morrow's buſineſs. I'll beg leave therefore to defer my reply until I am permitted to wait on you again.

Phil. So do, *Agricola*; and mind, examine every propoſition thoroughly, and call on me when it is altogether convenient to yourſelf.———Adieu.

CON-

CONVERSATION II.

AGRICOLA.

I HOPE you are well, Sir, and have had an eaſier mind ſince we parted than I have had.——I muſt tell you, Sir, that between your doctrine of theory, and the contrary opinion, of huſbandry being perfect without theory, as our fine crops and other great ſucceſſes teſtify, I have not ſlept ſince parting; and muſt moreover tell you, that I am ſtill exceedingly doubtful of the facts; that is, whether huſbandry is under as great a neceſſity of theory as the ſcience of medicine; or whether it is under any neceſſity of it at all.

Phil. YES, *Agricola*, I am in my uſual ſtate of health, and am glad to ſee you.—Your good conſtitution will not, I hope, by the want of one night's ſleep, and a little chagrin, ſuffer any material diminution: I am therefore glad our laſt converſation produced ſuch effects; becauſe in the extirpation of errors and enemies, nothing bears compariſon to ſolicitude and vigilance.—You will now call in a little patience, and as faſt as I can, I will endeavour to reconcile thoſe doubts.

WITH reſpect to the firſt propoſition indeed, (namely, whether or no huſbandry is under the ſame neceſſity of theory as the ſcience of medicine): as the fulleſt compariſon would not be of ſufficient importance to engage the attention of thoſe who may hereafter peruſe theſe converſations; and to yourſelf would be more a matter of curioſity than profit: I doubt not but a ſhort diſcuſſion of that propoſition will be altogether acceptable.

FIRST

FIRST then, as the uſe of medicine, whether applied internally or externally, is of ſuch excellence as to preſerve health in thoſe who enjoy it, and reſtore it to thoſe who are deprived of it: there is not the leaſt reaſon to ſuppoſe but medicine was wanted and prepared very early. However, until the circulation of the blood was diſcovered, which was not until the year 1628, the art was in a very imperfect and unſcientifical condition, as much ſo as huſbandry ever was. In the infancy of the art of medicine, the ſick were placed at the croſſing of roads and other public places, in order to be moſt in the way of travellers, to receive their inſpection and advice; they being ſuppoſed the beſt informed of all the people, relative to thoſe matters, as they had the greateſt opportunity of reading the chronicles of health*. This method, although very looſe and vague, (for the traveller had no data or ſure principles to go by, the rapidity nor languor of circulation, which is now well known to be the beſt criterion of a diſorder, being then not known); yet it was doing eminent ſervice to the *materia medica*. In like manner, although collections of facts relative to the effects of certain manures and modes of culture, upon ſoils of ſuch and ſuch complexions, for want of a better criterion than complexion, &c. to adjuſt their quantity and fitneſs to other ſoils, or even the ſame ſoils under different circumſtances, adventurers are frequently led into vaſt inconvenience: yet ſuch facts are valuable materials to huſbandmen, in as much as they are proved to be friendly in ſome inſtances to vegetation.

DISEASES in remote ages were neither ſo frequent, numerous, nor malignant as they have been in later times; which, in ſome degree, may be laid to the account of intemperance in diet and exerciſe; the ancients being in both theſe reſpects more circumſpect than the moderns: hence their ſimple noſtrums, which conſiſt-

* The chronicles of health were faithful narratives (engraved upon pillars, or written on the ſides of their temples) of all remarkable diſeaſes that had been remedied, and what the remedy was.

CONVERSATION II.

AGRICOLA.

I HOPE you are well, Sir, and have had an eaſier mind ſince we parted than I have had.——I muſt tell you, Sir, that between your doctrine of theory, and the contrary opinion, of huſbandry being perfect without theory, as our fine crops and other great ſucceſſes teſtify, I have not ſlept ſince parting; and muſt moreover tell you, that I am ſtill exceedingly doubtful of the facts; that is, whether huſbandry is under as great a neceſſity of theory as the ſcience of medicine; or whether it is under any neceſſity of it at all.

Phil. YES, *Agricola*, I am in my uſual ſtate of health, and am glad to ſee you.—Your good conſtitution will not, I hope, by the want of one night's ſleep, and a little chagrin, ſuffer any material diminution: I am therefore glad our laſt converſation produced ſuch effects; becauſe in the extirpation of errors and enemies, nothing bears compariſon to ſolicitude and vigilance.—You will now call in a little patience, and as faſt as I can, I will endeavour to reconcile thoſe doubts.

WITH reſpect to the firſt propoſition indeed, (namely, whether or no huſbandry is under the ſame neceſſity of theory as the ſcience of medicine): as the fulleſt compariſon would not be of ſufficient importance to engage the attention of thoſe who may hereafter peruſe theſe converſations; and to yourſelf would be more a matter of curioſity than profit: I doubt not but a ſhort diſcuſſion of that propoſition will be altogether acceptable.

FIRST

FIRST then, as the uſe of medicine, whether applied internally or externally, is of ſuch excellence as to preſerve health in thoſe who enjoy it, and reſtore it to thoſe who are deprived of it: there is not the leaſt reaſon to ſuppoſe but medicine was wanted and prepared very early. However, until the circulation of the blood was diſcovered, which was not until the year 1628, the art was in a very imperfect and unſcientifical condition, as much ſo as huſbandry ever was. In the infancy of the art of medicine, the ſick were placed at the croſſing of roads and other public places, in order to be moſt in the way of travellers, to receive their inſpection and advice; they being ſuppoſed the beſt informed of all the people, relative to thoſe matters, as they had the greateſt opportunity of reading the chronicles of health*. This method, although very looſe and vague, (for the traveller had no data or ſure principles to go by, the rapidity nor languor of circulation, which is now well known to be the beſt criterion of a diſorder, being then not known); yet it was doing eminent ſervice to the *materia medica*. In like manner, although collections of facts relative to the effects of certain manures and modes of culture, upon ſoils of ſuch and ſuch complexions, for want of a better criterion than complexion, &c. to adjuſt their quantity and fitneſs to other ſoils, or even the ſame ſoils under different circumſtances, adventurers are frequently led into vaſt inconvenience: yet ſuch facts are valuable materials to huſbandmen, in as much as they are proved to be friendly in ſome inſtances to vegetation.

DISEASES in remote ages were neither ſo frequent, numerous, nor malignant as they have been in later times; which, in ſome degree, may be laid to the account of intemperance in diet and exerciſe; the ancients being in both theſe reſpects more circumſpect than the moderns: hence their ſimple noſtrums, which conſiſt-

* The chronicles of health were faithful narratives (engraved upon pillars, or written on the ſides of their temples) of all remarkable diſeaſes that had been remedied, and what the remedy was.

ſiſted chiefly of draughts of vegetable juices, which were perfectly innocent; and having the aſſiſtance of untainted ſtamina, and the patient aſpiring to nothing beyond nature's common diet, proved often ſucceſsful.——Beſides the baneful effects of intemperance, conqueſt and commerce have contributed largely to the number and ferocity of diſeaſes all over the globe. For wherever the conquerors or adventurers came, they, in proceſs of time, introduced the diſorders peculiar to their own countries, and thoſe they had been in; the ſeeds of which, after they took root, although they may be quelled, can never be totally eradicated: and on their return, imported into their own countries the diſorders prevalent among thoſe they had viſited. Thus the diſeaſes of our nation have been extended to the moſt diſtant climes; and thoſe peculiar to them taken root amongſt us. On which account there is a probability that at leaſt nine-tenths of the diſorders now known in *Britain*, are exotic; and experience pronounces them exceedingly more virulent than diſorders of *Britiſh* origination Under ſuch a vaſt accumulation of diſeaſe, and declenſion of temperance, if the adorable Author of Nature had not bleſſed the labours of ingenious men, who have employed their time and abilities in phyſical reſearches with ſucceſs, in as much that they have been able to eſtabliſh a true theory of health, we ſhould long 'ere now, inſtead of being the greateſt conquerors, (if thought worthy of it in ſuch an emaciated condition) been conquered ourſelves.

THIS much, *Agricola*, I thought neceſſary to premiſe, in order to confirm your opinion on the advantages of the true theory of health and medicine. I ſay the true theories, *i. e.* thoſe that have the united ſanction of reaſon and experiment: For thoſe that do not ſtand the teſt of both, are wild and ſpurious, and no way deſerving the notice of either philoſopher, phyſician, or huſbandman.

I SHALL next, if you have patience and leiſure, *Agricola*, preſent you with a comparative view, in as conciſe a manner as I am able, of the expediency of the theories of medicine and huſbandry.

Agric. I am no way ſtraitened as to leiſure, Sir; nor do I feel the approach of impatience in any reſpect, except for the diſcuſſion of your propoſition.

Phil. IN the firſt place, then, to inveſtigate the priority of the arts; if we had not ſacred hiſtory to determine the event*, the determination lies very conſpicuous in the nature of things: for as it is the diſorders of adults, even in our days, (not thoſe which ſometimes attend mere infancy, ſuch as teething, &c.) that require the aſſiſtance of medicine; it is plain that food, which could not be wanted one day, was firſt in demand: hence, as food in the moſt early times was, as well as it now is, the reſult of huſbandry; it follows, that the art of huſbandry preceded the art of medicine. It alſo follows, as life depends more upon ſupplies of food than medicine, or the reſult of any other art, it is of more importance to mankind than any other art. The art, therefore, which is the moſt important, ought, without doubt, to be beſt underſtood. And as the united reſults of obſervation and reaſon, or a theory confirmed by experiments, bids the faireſt to explore the myſteries peculiar thereto; if, then, it can be made appear that the art of huſbandry doth admit of any myſterious circumſtances, I am at the greateſt diſtance from imagining *Agricola*, or any other ſenſible huſbandman, capable of ſuch obſtinacy as to perſiſt in a contrary opinion or argument.

Agric. THAT there are myſteries in the art of huſbandry, no one hath preſumed to diſpute; but it is, however, the opinion of moſt huſbandmen, that practice alone is ſufficient to unfold them.

* *Geneſis*, c. iv. v. 2. "*Abel* was a keeper of ſheep, *Cain* was a tiller of ground:" theſe are the firſt occupations mentioned.

Phil. THE following inſtances (although very eſſential to the art of huſbandry, as much ſo, I dare ſay, as the knowledge of anatomy and the whole materia medica is to phyſicians) are ſo entirely the offspring and reſult of reaſon and analogy, and ſo far beyond the province of practice alone to inveſtigate, (although happily within its influence to receive confirmation) that it may be preſumed, while the ſun and ſyſtem endure, they would not all have been diſcovered by it, nor applied with propriety.

1. THE diſcovery of a full eſtimate of the food of plants.

2. THE manner in which the food is received.

3. THE parts which receive it.

4. THE œconomy of thoſe parts.

5. THE method of inveſtigating, with preciſion, the diſeaſes and failure of crops.

6. THE beſt methods of preventing thoſe diſeaſes and failures.

7. THE nature and operation of manures.

8. THE method of determining, whether what are called manures do, or do not, act as ſtimulatives, abſorbents, &c.

9. THE real uſe of the ſoil in the vegetable kingdom.

10. THE uſe of culture; and method to determine with certainty, the quantity that any given ſoil requires, to give the crop the greateſt advantage.

11. THE evidences that determine which are the beſt ſoils.

12. THE

12. THE true grounds for determining what are the beſt quality of ſeeds, and what are the beſt methods of treating them, in order to preſerve and promote their prolific capacity, &c.

THESE intereſting particulars, with many more which may be inſtanced, are, I ſay, beyond the reach of practice alone preciſely to explore. Practice, in the moſt general ſenſe, comprehends nothing beyond the act of performing. A few remarks may be made, I own, by a mere practitioner; but it would be abſurd to take ſuch as criterions, until they have ſtood the teſt of reaſon and experiment: becauſe the remarker is not maſter of the ratiocination of his ſubject. If we even recur to the ſcience of muſic, which has its criterion in ſenſe, (the perfect ear being adapted to reliſh melody, and diſtinguiſh concord from diſcord with the greateſt accuracy); yet performers who entirely rely on the ear, often are found to deviate greatly from the key of the compoſition. Hence the neceſſity and uſe of ſet muſic or theory.

I AVER to you, *Agricola*, there is not one upon earth enjoys more ſatisfaction in ſeeing an ingenious and exact practitioner in any art or ſcience, than myſelf. I alſo acknowledge practice is as eſſential to buſineſs, as the body is to the ſoul, in the performance of mechanical operations. And with equal propriety might I aver, that practice without theory, is like ſetting the body to work, and the ſoul to ſleep. They are equally impracticable: for every practitioner has a kind of theory. He either imitates what he hath ſeen; doth as he hath been directed; or purſues his own plan. Therefore to ſtartle at the name THEORY, is ſtrange and unaccountable.—But the greateſt inconvenience to be apprehended is, that thoſe theories are not genuine: for it is as arrant an impoſſibility for a perſon to give directions to perform a piece of work according to art, who is not verſed in the elements or firſt principles of the art himſelf, as it is to prove an imitation an original. Nor are the neceſſary documents to be

acquired by random.—*Inſipientio*, who had been told that there was but a right and a wrong way of any thing, ſet about making a ſun-dial, without any previous knowledge in geometry, trigonometry, aſtronomy, or inſtruments; firmly relying on the adage, he concluded, that at worſt he would only have two to make; becauſe if he did do wrong at firſt, as there was but a wrong and a right way, next trial ſhould in courſe be the right. The conſequence was, that after he had made almoſt as many as there are days in the year, every one of them was wrong; which, to his coſt, convinced him that he had miſunderſtood the moral of the adage.

Agric. HA! ha! And ſo they would all have been, had he kept on making to the end of his life, I dare ſay. But had he taken the dimenſions of a true dial, and laid them down on his own plane, I ſuppoſe he might have come at the right.

Phil. THE conduct of this ſimple man, I own, *Agricola*, has ſomething ludicrous in it: and I agree with you, that to copy exactly a truly ſcientific practice, is the beſt ſuccedaneum for theory.——But as theory in moſt ſciences is attainable with eaſe and convenience; and as it enables us to help ourſelves, makes us leſs obnoxious to incidental error, &c. it ought to be preferred. For had *Inſipientia* even been ſo ſagacious as to have taken the exact dimenſions of every part of *Aſtronomus*'s dial, which certainly is a true one; yet his ſituation being many miles ſouth of *Aſtronomus*'s, there would ſtill have been an error, which he knew not how to rectify.

IN a word, *Agricola*, unleſs we could perſuade ourſelves that every thing we behold in nature is the effect of mere chance, (which, by the bye, would be offering violence to both our reaſon and ſenſes) we cannot have a pretence to imagine it poſſible for us to make any conſiderable progreſs in ſcience, or approximate to the truth of theory at random. Becauſe the whole frame

frame of nature, and every part thereof, is under the dominion of uniform laws, laid out by the adorable Author of Nature, the beſt ſuited to anſwer every purpoſe which HE intended the whole or any part of creation ſhould anſwer, through eternity. Hence, the direct way for us to aſſiſt nature muſt be, to do it in a manner conſiſtent with thoſe laws: which method can only be diſcovered by being intimately acquainted with them. It is true, there are many people dextrous in handy-crafts, who attend to no other theories than thoſe which practice and imitation furniſh; but ſuch, when you have attended to their buſineſs, you will find are rather demoliſhers of nature, than promoters of it. Such, therefore, are not to be claſſed with your profeſſion; which may with propriety be conſidered as the hand-maid of nature, and the baſis of all profeſſions.

I MUST now tell you, *Agricola*, that it would be exceedingly unphiloſophical, as well as unneceſſary, to ſpend any more time in giving inſtances, although thouſands are at hand, of the utility of a juſt theory to your profeſſion.

I THEREFORE deſire you will, at your leiſure, peruſe theſe papers, (and allow them to be peruſed by others, if you think proper) which contain the ſubſtance of our preceding as well as this evening's converſation; and when it ſuits you again to call on me, I ſhall be very glad to have your concurrence, or to anſwer any doubts that may ariſe relative to the ſubject. And for the preſent, I fancy it will not be unacceptable to you, if we turn our thoughts on the little buſineſs you formerly propoſed, although of a different nature.

Agric. I own I am greatly pleaſed with this evening's converſation: nothing ſeems more intereſting to me, than the privilege I enjoy of receiving ſuch leſſons. I ſhall with pleaſure peruſe the papers, and wait on you as ſoon as poſſible: and we ſhall enter on the other buſineſs, if you pleaſe.—But, let me ſee, what does the clock warn for—mercy on us! 'tis ten.——'Tis quite your hour, Sir.——Good night.

CON-

CONVERSATION III.

PHILOSOPHUS.

GLAD to ſee you, *Agricola*, you are really a ſtranger, you have been well, I hope.—I am entirely at leiſure, *Agricola*, and much diſpoſed for a lecture on huſbandry, if you'll ſit the evening.

Agric. QUITE well, Sir, and am come on purpoſe to ſit the evening; and return the papers, which I have attentively peruſed. They greatly aſſiſted my recollection, and ſerved as vouchers for my judgement with my neighbours; which otherwiſe, perhaps, would have been called in queſtion, when I intimated to them, that I was really of opinion, that theory would be of great uſe to us in the courſe of our buſineſs. I forbear to mention the reception my declaration met with; and my feelings in the ſingular ſituation I found myſelf in at the firſt onſet. However, before we parted, I could ſee myſelf in the eaſieſt ſituation of any in the company; for that ſort of perplexity which accompanies doubtfulneſs, ſeemed to have entered all their minds; and if I was not more reſpected than at firſt, I was, however, treated with more decency; and it was reſolved upon, that next day we ſhould meet, and that 'Squire *A*—— be requeſted to give his opinion on the doctrine of theory. Accordingly we all met at the time and place appointed; and we were honoured with the 'Squire's company, and many others that did not attend the firſt day. The ſtrangers ſeemed full of impatience to enter the liſts in defence of practice, and gave a little trouble; but my old antagoniſts were almoſt as ſilent as mutes at a funeral, relying entirely on the 'Squire's deciſion on the matter. He deſired to peruſe the papers,

papers, if you had left me at liberty to produce them; which I readily did, and he gave them an impartial review: read them again and again to the company, and desired every one would make their objections; which drew out various strictures on the bad success of theorical husbandmen: this had well nigh brought me to my former singular situation; but upon Mr *A*——'s desiring they would explain the theory those unsuccessful gentlemen had pursued, the scale turned. For when the explanation was given, it was found their pursuits all originated in Mr *Tull*'s Drill Husbandry, which he said was very different from what he apprehended you meant to inculcate: because your plan recommended the investigation of the laws of nature, the knowledge of the organization and food of plants, and their ultimate purposes, &c. as the foundation of your theory, without the least attachmment to either the drill or common system of husbandry in particular.

THE mode of culture, he observed, according to your theory, would therefore depend upon circumstances, and consequently would be as free as the will of the occupier. And concluded, that as to his own part, he was as thoroughly convinced of the propriety of such a theory, as he was, that there is a city called *Constantinople:* and added, that in his opinion, husbandry might by such assistance, receive as much improvement, as the art of sailing had by the discovery of the needle and compass. Before that happy epocha, says he, mariners, like many husbandmen, dared not to shift one inch from the common tract; but since the principles on which the needle's indication depends, has been investigated, they traverse the ocean at large, and can perform a voyage round the world, almost as soon, and with more safety, than they could (before its theory was given) make a voyage round *Britain.* —The conversation then became general, and very serious; and ended in the resolution, that if such a theory as you propose could be acquired without weakening the active arm, by indulging youth in effeminacies, &c. at such schools as teach the re-

requiſites for ſuch enquiries, or by detaining them longer there than is conſiſtent with their fortune, and days of leiſure, it could not fail of doing eminent ſervice in huſbandry.—They preſent their dutiful reſpects, Sir, and hope you will oblige them with your opinion on that particular.

Phil. IT gives me the higheſt ſatisfaction, *Agricola*, to hear the papers were ſo ſerviceable; I ſhould be greatly deficient in common civility, did I not acknowledge my obligation to Mr *A*——, for the compliment he makes me; and at the ſame time congratulate you, on account of your ſucceſs. To be able at once to ſtem, and even reduce to a calm, ſo violent a current, as the prejudice of common opinion,—is an irrefragable proof of the addreſs and ſolid ſenſe of the appellants; and of the candour and venerable flexibility of the defendants. You may reſt aſſured, *Agricola*, there is nothing I am able to beſtow, ſhall be withheld from ſuch an amiable aſſociation. With reſpect to the requeſt of your neighbours, (whom I truſt not to common fame for a character of) being perſonally acquainted with many of them, I am, in ſome meaſure, prepared to anſwer; having, at my leiſure, many years ago, compoſed a ſyſtem of education for the youth of *Ceres*. But had it not been at ſo reſpectable a requeſt, I ſhould have waved that matter for the preſent; having a method ſuited to every age and capacity for underſtanding my theory of huſbandry, (as I formerly mentioned to you). However, as your worthy neighbours (I will not doubt) have received that hint from you, yet think proper to make ſuch a propoſal, I am truly obedient to their reſolution; and am alſo at the greateſt diſtance from imagining it at all improper. Becauſe, although the method I have to propoſe for the information of huſbandmen in general, requires no very great extent of learning in the pupil, to render it eaſy and practicable in ſome degree; yet ought it to be premiſed, that in proportion to the extent of ſuitable education, (every other circumſtance being equal) the de-

gree will riſe. To ſpend as little of your time as poſſible in preamble, I ſhall preface no more on the occaſion, but enter immediately on a plan of education for youth intended for the profeſſion of huſbandry.

YOUTH intended for that laborious, though intereſting profeſſion, require (in their infancy) no other treatment than what is common to thoſe intended for other profeſſions, viz. a due care of their temperance, good example, and proper exerciſe:— on which depend many perfections of both body and mind, that are moſt deſireable in manhood. In a word, let the cloathing and diet be as ſparing, and the exerciſe as great as an uninterrupted ſtate of health can admit. No oppreſſion; little indulgence; and as to the example, let it be moral and devout: ſteering clear, however, of old-wifery and pious fraud. If ſuch attention is alſo given to the dialect and pronunciation, as to form their language to the national ſtandard, they may one time or other be benefited thereby; eſpecially if they have occaſion to be in places diſtant from that of their nativity. I have ſeen men who knew not *p* from *q*, by being habituated in youth to hear and ſpeak the ſtandard language, have more addreſs and ſentiment, than others who had been taught reading, writing, and the uſe of numbers; and no way inferior in judgement, but embarraſſed with a vicious pronunciation, and a bad arrangement of words or ſigns of ideas. It is in the nurſe's hand that diſtinct pronunciation may be acquired with moſt eaſe: and then, and as ſoon after as may be, that the proper names of things, and true ſigns of ideas be grafted in the memory. After which, to accuſtom them to hear nothing but clear, deciſive anſwers, and interrogations, conciſe and fair reaſonings, are the likelieſt means at that age to enrich and cultivate the ſoul. At ſix, or perhaps five years old, if healthy, they ought to be put to ſchool, and there continued, (if health permit) until they are completed in reading, *Engliſh* grammar, writing, and accounts. And if taught to make

a graceful bow, &c. ſo much the better; for I ſee no reaſon why a farmer, more than any other reputable man, ſhould appear or be aukward in any reſpect.

THIS circle of inſtruction, provided they are under the care of proper maſters, may be perfectly accompliſhed in four or five years; during which time the utmoſt attention ought to be paid to the above particulars, and to their general deportment: encouraging by every means diligence, cleanlineſs, activity, acuteneſs, and probity: taking alſo care to mark with due diſreſpect whatever is ſlovenly and mean. And above all, the golden axiom, *Do to others, as you would have them do to you*, ought to be urged, both in example and precept, at this ſeaſon. Becauſe, youth about that age, have an exceſſive deſire to be poſſeſſed of ſuch things as pleaſe the animal nature; hence, if the divine or rational nature is not kept a full match for thoſe deſires, opportunity will certainly induce them to embrace unwarrantable gratifications; which once grown to habit, may prove irremediable. The axiom ought, therefore, in the fulleſt extent, to be inculcated, as it is the moſt faithful monitor; containing not only the eſſence of every human inſtitution worthy of notice, but alſo the will of the Eternal and Adorable GOD! Univerſal benevolence (the great law implanted in the human ſoul) if cheriſhed and continually oppoſed to ſelf-love, (the great law of the body) conſtitute the line of moral rectitude, on which, excluſively, the Lawgiver cauſeth his influence to deſcend. And it can only be from ſuch a walk, that the ſoul, after it is diſengaged from its opponent, can aſcend with ſatisfactory reſponſes.* *To do as we would be done to*, is therefore a rule or axiom of the higheſt importance to

* This may perhaps be taken as a new idea of morality; however, let the reader beſtow a thought on it; let him review the works of GOD throughout, and try, whether he can diſcover an inſtance where the Creator doth not effect his deſign by oppoſing one power to another. An attracting and a repelling power, (although the greateſt oppoſites) conſtitute the ſtupendous motion and harmony ſo conſpicuous in the ſolar ſyſtem. It is not when the influence of the ſun's beams are the greateſt, nor when the

mankind; becauſe while ſoul and body are together, it yields them the greateſt conſolation; and when the latter is no more, it ſecures to the former the everlaſting approbation of the adorable GOD.

OUR youth may reaſonably be ſuppoſed now to have ſtrength enough to enter upon their profeſſion; and a father or a maſter's prudence will readily ſuggeſt, that their confinement and labour muſt be moderate at firſt. After they have been made ſenſible of the hazard they are in of being hurt by the creatures and utenſils peculiar to the profeſſion, and the moſt effectual ways of guarding againſt that danger, pointed out; they may be ſuffered to handle them in a degree which neither offends the creatures, the maſter, nor themſelves. Every action, at firſt, muſt be calculated to yield pleaſure; and the beginners called off before wearineſs gives them the leaſt diſguſt. They will, by ſuch management, (eſpecially if their companions are diſcreet) be preſſing to be employed; and as deſire and ability mutually encreaſe, they may be ſuffered to augment their hours of labour. However, care muſt be ſtill taken that they do not exceed their meaſure of ſtrength and inclination: and although it is very neceſſary to accuſtom youth to execute their work neatly, it may perhaps, be a detriment to youth educated in the above rationa and delicate manner, to reprimand a deficiency of that ſort; but highly beneficial to commend their attempting to exceed in expedition, as well as neatneſs. They will ſoon perceive the drift of ſuch a treatment; and their endeavours to pleaſe (if they are endowed with that generoſity of ſoul, which, we preſume, ſuch an education bids fair to excite) will be greater than if the ſevereſt engines

earth's cold predominates, that the great work of vegetation ſucceeds beſt; but when their neutral reſult obtains, *&c. &c.*

IN inanimate nature, the primary laws of action are invariable and irreverſible by human power; but in rational nature, they are left to its own guidance. Herein conſiſts the dignity and pre-eminence of that nature; and the reaſonableneſs, nay juſtice, of its being made reſponſible for its conduct.

engines of chaſtiſement had been played off againſt them. Such conduct in a father or maſter, is big with the moſt ſubſtantial advantages: for while their children or ſervants are with them, nothing obtains but mutual kindneſs, and the interchange of good offices; and when they part, there is left no cauſe of remorſe.——Our youth being now engaged in the purſuit of the art of their profeſſion, will, if not kept to it, forego their ſchool-learning: it will be neceſſary, therefore, to ſet a convenient portion of their time apart for the exerciſe of thoſe acquirements. And as they have only been taught reading, writing, and accounts; thoſe abilities may be employed in the concerns of the family: the firſt in reading common occurrences, news-papers, &c. as well as literature of a more ſerious nature; and the ſecond and third in keeping a regiſter of the daily accounts and tranſactions relative to the farm, &c. And as I have been favoured by an acquaintance with a very comprehenſive form for a weekly regiſter of the expenditure, receivings, &c. of a farm; and am at liberty to make uſe of it, I ſhall do myſelf the ſatisfaction to inſert it for their directory.

The Form of a WEEKLY REGISTER *of the Expenditure in a* FARM.

Monday, May 3, 1773

3 men, 3, 4, 5, plowing in high field
2 men, 1, 7, at harrow in ditto
2 men, 6, 9, threshing wheat
2 men, 2, 8, hedging in low field

Tuesday, 4th.

3 men, 3, 4, 5, plowing in high field
2 men, 1, 7, at harrow in ditto
2 men, 6, 9, threshing wheat
2 men, 2, 8, hedging in low field

Wednesday, 5th.

3 men, 3, 4, 5, plowing in high field
2 men, 7, 8, at harrow in ditto
1 man, 9, threshing wheat
1 man, 2, hedging

Labourers' names	Mon	Tue.	We.	Th.	Fri.	Sat.	Rate per day.	No. of days	£.	s.	d.
1 Adam Fell	1	1	0	1	0	1	10d.	4	0	3	4
2 Benj. Stout	1	1	1	1	1	1	1s.	6	0	6	0
3 Cha. Fair	1	1	1	1	1	1	1s.	6	0	6	0
4 David Jolly	1	1	1	1	1	1	1s.	6	0	6	0
5 Edward Hart	1	1	1	1	1	1	1s.	6	0	6	0
6 Frank Folly	1	1	0	1	1	1	8d.	5	0	3	4
7 Geo. Trueman	1	1	1	1	1	1	10d.	6	0	5	0
8 Hen. Hopeful	1	1	1	1	1	1	1s.	6	0	6	0
9 John Slight	1	1	1	1	1	1	8d.	6	0	4	0
Saturday, paid poor rate, —d. per pound									3	7	4
——— paid for 200 loads of dung, at 1 s. per load									10	0	0
Profit and loss paid this week								£.	15	13	0

Thursday, 6th.
3 men, 3, 4, 5, plowing in middle field
2 men, 2, 8, draining high field
2 men, 6, 9, threshing wheat
2 men, 1, 7, at market, with each a cart-load of wheat

Friday, 7th.
3 men, 3, 4, 5, plowing in middle field
2 men, 2, 8, hedging in high field
2 men, 6, 9, threshing wheat
1 man, 7, at —— fair with four oxen

Saturday, 8th.
3 men, 3, 4, 5, plowing in middle field
2 men, 2, 8, hedging in high field
2 men, 6, 9, threshing wheat
2 men, 1, 7, with each a cart and 3 horses at statute-work on ——— turnpike

IN the preceding form, the whole expenditure and tranſactions relative to a farm may be regiſtered; and on the oppoſite folio, a form as under will ſerve to regiſter the whole income thereof.—Hence, at the end of the year, by carrying forward the weekly ſums in the order they are regiſtered, and placing the aggregate of the ſums expended againſt the aggregate of the ſums received, the loſs or gain upon the farm will clearly appear.

The Form of a Weekly Regiſter of the Receivings in Farm Buſineſs.

1773			£.	s.	d.
From *May* the 3d to the 9th, both days included	6	By what was received for 80 buſhels of wheat, at 6 s. per buſh.	24	0	0
	—	By what was received for 11 lb. of butter, at 8 d. per lb.	0	7	4
	7	By what was received for four oxen (bought for ——) as per regiſter of expenditure, the 15th of *Oct.* laſt	35	0	0
		&c. &c.			
		Profit and loſs rec. this week £.	59	7	4

KEEPING

KEEPING ſuch regiſters, *Agricola*, beſides furniſhing exerciſe for youth in their writing and accounts, will yield the farmer great ſatisfaction at a very trifling expence. He may, as often as he thinks ſuch an inveſtigation neceſſary, by examining the book, find how much any particular piece of work ſtood him; what he gained by any bargain; how many plow-dargues any field is; and when it was plowed, &c. He may alſo end, or rather prevent any diſpute with his workmen, relative to the number of their days-works, by producing the book. And if a maſter is from home, or engaged in other buſineſs, his hind or ſteward cannot produce better vouchers for his outlays, than the book doth furniſh; as it alſo contains the month-day and week-day, and the particular employment every ſervant was at throughout the year, when the figure preceding the name is noted in the table containing the buſineſs of the day; as in the ſpecimen here given.

Agric. WHAT you have been pleaſed to deliver this evening, Sir, meets my hearty concurrence. I am unable, indeed, to expreſs a full ſenſe of the obligation you lay me under, and the pleaſure I enjoy in thoſe evenings of inſtruction. But it is my duty, and I will beg leave to deſire you may not make it inconvenient to yourſelf by over-fatigue.—It is now far paſt the uſual hour of parting—it muſt be wrong in me to retard your repoſe one moment longer. Good night.

Phil. ADIEU!

CONVERSATION IV.

PHILOSOPHUS.

I AM glad to ſee you, *Agricola*.

Agric. I HAVE again ſtepped over to ſit the evening, Sir, and deſire you will be pleaſed to reſume the ſubject, if health and opportunity favour my requeſt.

Phil. YOUR requeſt is quite agreeable; and I can at once lay my finger on the ſubject. We had juſt concluded an account of the regiſter of farm buſineſs; ſubſequent to which ſtands the form of a ledger or book, wherein the true ſtate of every perſon's account, that has dealings with a country gentleman or farmer, may be readily found alphabetically: and ſuch a ledger may alſo be worked by our youth with pleaſure and convenience in an evening, as the tranſactions of ſuch gentlemen ſeldom require above three or four entries *per* day, often none. The face of the book renders much direction to work it unneceſſary; however, ſuch as is wanted, together with the form of the book, and conſtruction of its index, or alphabet, ought to be ſubjoined, and are as follow.

The CONSTRUCTION *of its* ALPHABET.

A Addiſon, Ch. page 1.x	E	I	N Nicholſon, H. page 1, 2	R	W
B	F	K	O	S	X
C	G	L	P	T	Y Young, Jas. p. 2, 21, 35 x
D	H	M	Q	U V	Z

N. B. IF a croſs is made, as under *Addiſon, Ch. &c.* in the index, to indicate the account is balanced, it will ſave much trouble to the book-keeper.

DIRECTIONS *to uſe the* ALPHABET.

IN the table which bears the initial letter of the perſon's ſir-name that has taken credit, or become a creditor to the proprietor of the book, enter as follows, viz. Suppoſing the perſon's name to be *Charles Addiſon:* in the firſt table, find the initial of *Addiſon*, and write *Addiſon, Ch.* page.* The reaſon why the name is tranſpoſed, that is, why you are to write the ſir-name before the chriſtian name, is, to avoid in general the inconvenience of crowding one table more than another; becauſe chriſtian names have not ſo great variety as ſir-names. Hence the whole alphabet will come more into play, in even the ſame tranſactions, than where the chriſtian names are put firſt; conſequently, the alphabet endures longer. However, if the book contain four or five quires of paper, it will, at all events, be proper to ſpare three or four leaves at the beginning, to make new alphabets, ſhould the names fall out ſo ſimilar as to fill a few tables before the others have perhaps been wrote in, or by frequent entries of the ſame name, &c. &c.

* The book is to be paged on *Dr.* and *Cr.* ſide with the ſame figures, viz. (1) (1) or (2) (2) &c. &c. and whatever figure the page bears in which the perſon's account is entered, let it be put after the name in the table or alphabet, every time an entry is made.

The Face of the LEDGER DEBTOR:

OR,

Folio which receives the Entries of every Account which makes the Proprietor Creditor, either to others or his own Stock.

Page (1) **LEDGER.**

1773	*Charles Addiſon*, of *D——m* *Dr.*	£.	s.	d.
January 1	To 24 buſh. of wheat, at 6s. per buſh.	7	4	0
8	To 12 ditto, at ditto — — —	3	12	0
15	To 18 ditto, at 5s. 10d. per buſh.	5	2	0
22	To 24 ditto, at ditto — — —	6	16	0
29	To 16 ditto, at 6s. per ditto — —	4	16	0
	£. 27 10 0			

1773	*Henry Nicholſon*, of *E——r*, butcher, *Dr.*			
Jan. 22	To 11 wedders, at 1l. 14s. each	18	14	0
29	To 7 ditto, at ditto — — — —	11	18	0
Feb. 5	To 5 ditto, at ditto — — —	8	10	0
12	To 2 oxen — — — —	26	0	0
April 19	To 2 oxen — — — —	30	15	0
26	To 1 ox — — — —	17	17	0
June 21	To a ſcore of lambs — — —	13	10	0
	Carried to page (2) £. 127 4 0			

The Face of the LEDGER CREDITOR:

OR,

Folio which receives the Entries of every Account which makes the Proprietor Debtor, either to others or his own Stock.

	LEDGER.	*Page* (1)		
1773	*Charles Addiſon*, of *D——m* *Cr.*	£.	s.	d.
Jan. 15	By caſh, for which I gave him receipt to account — — — —	12	12	0
29	By the full balance of accounts from the 1ſt inſt. to this day, both included	14	18	0
	£. 27	10	0	
1773	*Henry Nicholſon*, of *E——r*, butcher, *Cr.*			
March 22	By caſh, for which I gave him receipt to account — — — — —	21	0	0
June 4	By a ſurloin of beef, at 3¾d. per lb. 37 lb.	0	11	6¾
21	By a quarter of lamb — — —	0	3	0
	Carried to page (2) £. 21	14	6¾	

(2) LEDGER.

1773		*Henry Nicholſon*'s account Dr.	£.	s.	d.
		Brought from page (1) — — —	127	4	0
July	12	To a ſcore of lambs — — —	14	0	0

1773		*James Young*, of *W——h*, ſmith, Dr.			
March	6	To caſh paid him, for which I took his receipt to account, as per file — —	1	1	0
		Carried to page (21) £.	1	1	0

LEDGER. (2)

1773		*Henry Nicholſon*'s account. *Cr.*	£.	s.	d.
		Brought from page (1) ——	21	14	6¾
July	19	By caſh, for which I gave him receipt to account — — — —	52	10	0
Auguſt	16	By caſh, for which I gave him receipt to account — — — —	31	10	6

1773		*James Young*, of *W——h*, ſmith, *Cr.*			
Feb.	1	By an account of work done for me from January 1, to the laſt of the ſaid month, as per file — — — —	0	7	3
March	1	By an account of work done for me from February 1, to the end of that month, as per file — — — —	0	4	7
April	1	By an account of work done for me from March 1, to the end of that month, as per file — — — —	0	6	4
		Carried to page (21) £.	0	18	2

In this order, *Agricola*, may the accounts of any private perſon be kept, without journal or waſte-book, and readily inſpected. I have been told by farmers, I confeſs, that keeping ſuch minute accounts is next to labour in vain; for, ſay they, it is eaſy to bear ſuch tranſactions in memory: and I doubt not but you have often been witneſs to the like aſſertions. However, ſuch fallacy and indolence muſt by no means be complied with. It is impoſſible to eſtimate the inconvenience and anxiety which await a neglect of this kind.—The legiſlature have thought a regular book-keeping worthy of their ſanction, and have enacted, that whenever a regular book is kept, and goods, &c. which have been delivered, are regiſtered therein by a ſon or ſervant, the book ſhall be equally good as the perſon's note of hand. If there were no other reaſon for keeping a regular account in books, this has weight enough to overbalance every pretence which can come againſt it: but beſides it, there are abundance of others equally cogent. Many are the diſputes and wranglings which happen between maſters and ſervants relative to accounts, for want of this neceſſary precaution.—Often have I known maſters ſink in common fame, by deciſions before Juſtices, &c. for want of ſuch a voucher: and often have the modeſt labourers ſuffered both in circumſtances and reputation, rather than fall out with maſters; and at the ſame time the maſters, without real deſign of committing fraud, having forgot the true ſtate of the account; yet their ſuperior ſtation and pride enable them to bear away the argument. In ſuch a caſe, there is no alternative for the poor labourer but ſubmiſſion; and then, if the maſter is not very ingenuous indeed, the ſervant has but little chance to be re-imburſed. An inſtance of which, however, I know did happen; and the maſter did not only comply with the demand of his honeſt labourer, but ſincerely regretted the cauſe of refuſal: declaring, that for the future he would, for his part, never truſt to memory ſuch tranſactions and accounts.

In

IN ſhort, *Agricola*, there is not a point of view we can place the neglect of accounts in, that does not reflect obloquy on the perpetrators. Suppoſe they alledge, and are able to demonſtrate, that they have an excellent ſhare of memory: a judicious perſon will inſtantly ſuggeſt, that they alſo exceed in indolence and want of taſte; becauſe that excellence of memory they are bleſſed with, did they uſe it properly, ought to be reſerved for, and ſtocked with ideas of a ſublimer nature. There is not a man upon earth ſo ridiculous as to inſiſt that he would do well, when he had got a week's proviſion in ſtore, to carry it continually in his hand, while it laſted, when he has a place of greater ſafety and convenience to depoſit it in. And ſorry I am to entertain the thought, that a man can be found ſo ridiculous, as to inſiſt he doth well in making his memory his account-book.—A circumſtance equally abſurd.

Agric. Too many have erred in that matter, I own, Sir; but now a great reform has taken place. In the circle of my acquaintance, I know none but neighbour *Tenax* that does not keep a book. In my tranſactions I have experienced great utility and ſatisfaction from the manner I keep a book. I find it alſo particularly convenient to have a memorandum-book to regiſter experiments, &c. in; and one wherein I make entries of all bargains, and in which I deſire my tradeſmen, &c. to write receipts. I find no inconvenience of carriage in the little book; and at market, &c. it is ready when public-houſe paper is not to be found; and unleſs I loſe my book, (which a good pocket effectually prevents) I cannot loſe a ſingle receipt, nor be plagued with perhaps an hour's ſearch after it; as was the caſe when I uſed to depoſit receipts, &c. in drawers and parcels. And I am convinced that even that book may be greatly improved by paging it, and prefixing an alphabet or index, as directed in the foregoing ledger.

Phil. You would moſt certainly find your materials with more facility and eaſe. Such inferences are of every ſpecies of retaliation, the moſt acceptable. To diverſify inſtruction, and diſperſe it indiſcriminately to the remoteſt corner of its province, truly beſpeaks genius, and commands honeſt praiſe.

I HAVE only now, on this head, *Agricola*, a few particulars to advert to huſbandmen and their pupils. Firſt, that when they receive any money, it is extremely impolite and uncivil not to offer a receipt: it is no leſs ſo in every other perſon. Hence, if thoſe you pay money to, do not offer a receipt, it can be no rudeneſs to demand it; and making a tender of a book or paper for that purpoſe, is a very genteel way of requeſting it. However, by no means neglect to obtain it, for ſuch neglects have been the ruin of many families. And as theſe papers are intended for the edification of youth, as well as to be laid before your aſſociation, it may not, perhaps, be thought foreign to inſert the form of a few receipts, &c. proper to be given on the following occaſions.

Form of a Receipt on ſettling Accounts.

January 29, 1773.

RECEIVED from the hand of Mr *Charles Addiſon*, the ſum of fourteen pounds eighteen ſhillings, in full of all accounts. Witneſs my hand, the date above.

JOSEPH MEANWELL.

£. 14 18 0

Form

Form of a Receipt for Money paid in Part of an Account, by the Servant of the Principal.

March 22, 1773.

RECEIVED from the hand of *James Truſty*, ſervant to Mr *Henry Nicholſon*, whom the ſaid *James Truſty* in this matter repreſents, the ſum of twenty-one pounds; which ſum I hereby promiſe to place creditor to his account. Witneſs my hand, the date above mentioned,

JOSEPH MEANWELL.

To account £. 21 0 0

Form of a Receipt to be given by a Servant, when he receives Money to Account, or in full of Account for the Uſe of his Maſter.

April 19, 1773.

RECEIVED from the hands of Mr *Benj. Punctual*, the ſum of five pounds, by the order and for the uſe of my maſter, *Joſeph Meanwell*. Witneſs my hand, the date above.

JAMES USUAL.

£. 5 0 0

WHEN a ſon receives money for his father, he ſhould give the ſame receipt as a ſervant, only ſay inſtead of his maſter, his father. It is alſo proper to obſerve, that the maſter or father always ſhould ſend with his ſervant, or ſon, on theſe occaſions, a letter mentioning the ſum the bearer is to demand; otherwiſe he takes a liberty with all parties.

The Form of a Receipt for Rent given by a Steward.

July 20, 1773.

RECEIVED from Mr *Thomas Rudd*, in caſh and accompts, as under, his half year's rent, due *May-day* laſt, for the *South-Field* farm in the townſhip of *Thrivewell*, the property of *Ralph Fair*, Eſq; by whoſe order, and for whoſe uſe I receive it.

RICHARD HART, *Steward.*

In Caſh — —	£. 96	0	0
Land-tax — —	3	0	0
Carpenter's bill for three new gates	1	0	0
Half year's rent - -	£. 100	0	0

Form of a Promiſſory Note, or ſimple Security for Money borrowed, &c.

July 12, 1773.

BORROWED and received of Mr *John Goodheart*, eight pounds; which ſum I hereby promiſe to pay to him or order, two months after date, (or upon demand, if it is ſo agreed upon*) with intereſt, at the rate of four per cent. per annum.

ROBERT NEEDFUL.

Witneſs,
JOHN FAIRLY.

The

* BUT it is running a riſk to lend money upon demand, becauſe unleſs the lender demand it in three days after lent, if the borrower ſhould fail, the lender has no claim to even a dividend as a creditor.——Promiſſory Notes and Book Debts muſt be demanded and acknowledged due within ſix years, otherwiſe they do not ſtand valid in law.

The Form of an Inland Bill of Exchange.

£. 20

NEWCASTLE UPON TYNE, *Jan.* 3, 1773.

FORTY days after date, with or without advice, pleaſe pay to Mr *John Traveller*, or order, twenty pounds (value received) and place it to the account of your friend and ſervant,

CHRISTOPHER CREDIT.

To WALTER GOLD, Eſq; banker, London.

BILLS of this nature are frequently preſented to countrymen in markets as payment for their commodities, but when neither the drawer nor the indorſer, or indorſers, are well known by the perſon it is preſented to, he may, without any breach of civility, refuſe it. Eſpecially, if he is not acquainted with the nature and manner of noting and proteſting bills, &c.

SECONDLY, I heartily recommend to the huſbandman, and every perſon in buſineſs, a peremptory demand of a note of particulars, with every parcel of goods they receive; and for every job of work performed by tradeſmen, whether in making new, or finding repair.——If it is convenient to make payment, ſuch note ſerves for the account; if not, it ought to be examined, and put in file until payment can be made, (which at fartheſt ſhould not exceed ſix months.) And then the notes and account are to be compared. This eaſy proceſs effectually prevents both impoſition and miſtruſt; being a voucher for the tradeſman, as well as a check upon the account. And, therefore, is a matter of ſuch conſequence, that no perſon that would be thought regular, ought to neglect it. At any rate, let thoſe who have ſons or apprentices,

tices, who are deſigned for huſbandmen and maſters, be trained to ſuch regularity. The education they have had previous to their entering upon the profeſſion, as heretofore ſet forth, makes them equal to the taſk; and their tender years and mental powers require part of their time to be otherwiſe employed than in hard labour.

THUS, *Agricola*, exerciſe may be had not only to enable youth to retain their ſchool-learning, but to improve it by reading to, writing for, and keeping the neceſſary accounts of their father's or maſter's families, from the day they leave ſchool, (which we propoſed ſhould be at their ninth or tenth year) until they arrive at their ſixteenth or ſeventeeth year. And how they are to be employed after, until they are of years, will make the ſubject of our next diſcourſe; which I ſhall gladly enter upon when you again find it convenient to call on me: but for the preſent, we will adjourn to the next apartment, and taſte thoſe fragments of bounteous nature, which *Soror* has arranged ſo neatly on yonder table.

CONVERSATION V.

PHILOSOPHUS.

THE great holiday intervening has made me think your abſence very tedious, *Agricola*; I am glad, however, you are now come.

Agric. I am again come, ſir, to deſire you will reſume the ſubject.

Phil. I intend it, *Agricola*.—In our laſt converſation we concluded the plan for employing the vacant hours of youth, in exerciſing and improving their ſchool-learning during their apprenticeſhip of ſeven years; in which time they ought alſo to be inſtructed in every branch of the manual and operative part of the profeſſion: and have, we hope, been taught to drive the plough, cart, waggon, *&c.* properly; that is, to give the word of command with judgement and confidence. I ſay with judgement and confidence, *Agricola*; for though they are mere animals they have to deal with in theſe operations, both reaſon and experience concur to ſupport the fact, that they are able to deſcry the leaſt ſpark of diffidence and want of judgement in their drivers, relative to the management of them while under the yoke, chain, *&c.* And ſo powerful is the principle of reſiſtance in them, that unleſs broke in by ſteady, good management, and that muſt be duly tempered with lenity too; that they will at all times, when occaſion offers, endeavour to reſume their liberty even at the peril of their lives. Indeed, thoſe that are beſt broke in, when their ſpirits are elevated by the example of their fellow-creature at play, *&c.* will make powerful efforts to

ſhake

ſhake off all manner of reſtraint. Hence the right government of animals is not to be effected by indolence, random, and indifference. It is truly the reſult of experience, temper, reſolution, and good-ſenſe.—It is really ſo much ſo, *Agricola*, that I will riſque my reputation on the aſſertion, that you may diſcern by the management of their teams, &c. *cæteris paribus*, which of your ſervants have the moſt ſolid ſenſe. The obſervation holds good in every ſpecies of management relative to animals; nor is the reaſoning without experiment to corroborate and confirm it.——Who have been the moſt ſucceſsful jockeys in your memory? I will venture to ſay you will grant it was the *J*——*ns:* well, and pray recollect, were not they uncommonly ſhrewd and ſteady?

Agric. THEY were, Sir. Nobody could pump their ſecrets, or divert them from prying into the minuteſt circumſtances relative to their cattle, and the foibles of their antagoniſts', &c. They were ſo dexterous in that profeſſion as to know almoſt for certainty, in every inſtance, (after they had ſeen the horſes run, and the management of their riders) who would take the prize; and were never known to loſe a race themſelves without the greateſt diſparity of cattle. In a word, they were both uncommonly ſingular in ſagacity and ſucceſs; and probably the latter was occaſioned by the former.

Phil. THERE are fifty other inſtances at hand to certify for the validity of the aſſertion; but it is miſpending time to dwell any longer upon a matter ſo ſelf-evident, and ſo deeply rooted in the nature of things: for animals, as well as men, having an utter averſion to uſurpers, will be watchful of, and eager to embrace an opportunity to break their bonds; and can, I doubt not, diſtinguiſh a dunce from an expert driver, as clearly as people did a *Richard* from an *Oliver*.* And finally, from

* OLIVER CROMWELL, by mere dint of ſubtility and judgement, became Protector of *England*; but *Richard*, his ſon, being a ſimpleton, was unable to keep what had been given to him.

from the many accidents which happen to thoſe who are the beſt qualified.

THE difficulties they have of conquering ſo ſtrong a bias, and completing their purpoſe, ought to deter people from appointing youth to that profeſſion, who are at all deficient in the above particulars. Let them not deceive themſelves, by imagining that experience will complete them: the experiment is by far too hazardous to be attempted. The creatures they have to deal with, will ſoon find out their weak ſide; and they are as prone to take the advantage, and even to devour, as they are void of remorſe. Beſides, if they are incapable of governing thoſe, they muſt be alſo unequal, as maſters, to every other branch of a profeſſion, which (of all others) from the precarioufneſs of ſucceſs, and its indiſpenſable influence, requires the greateſt abilities. Thoſe youth, therefore, who are remarkably deficient in their mental powers, ought rather to be put to drive the needle or the awl, than the team. But I mean no offence to the good people of thoſe profeſſions.—I only mean, that men, any way deficient in their intellects, have a better chance to receive juſtice among men, than among mere animals; becauſe the former, if they keep to the dignity of their nature, will be governed by reaſon and ſympathy, and alſo by the laws of their country; therefore will treat them with due reſpect: but the latter, being void of theſe, will aſſuredly take every advantage. And that a mere mechanical employment ſuit ſuch youth infinitely better than huſbandry, which certainly depends much on contemplation, as well as practice.

WE alſo hope that youth, who have been thought deſerving of being brought to your profeſſion, *Agricola*, have been taught to take proper care of the cattle, as well as to drive them properly. For as cattle are compelled to anſwer the demands (if able) of their managers; the managers ought,

therefore, to know the limits of their powers, and how to accommodate the demands of their nature; likewiſe the manner of employing thoſe powers without waſte. Hence the manner of harneſſing, and the conſtruction of the inſtruments they are connected to, become alſo the objects of the huſbandman's ſtudy and intereſt.* And if theſe are of conſequence to be known, it can be no leſs ſo, that youth have proper inſtructions to perform the various operations peculiar to their profeſſion, and be taught to judge of the excellence of plowing, harrowing, rolling, &c. &c. An Eſſay on thoſe particulars, I will, therefore, ſuppoſe, cannot be unacceptable.

Agric. EXCEEDINGLY agreeable, Sir. Theſe are operations of the utmoſt importance to us, and cannot be too much inculcated.

Phil. AND I ſhall eſteem it a happineſs if the following account of them prove of any real ſervice to the art: ſo ſhall proceed in the ſame order we have now mentioned them, *viz.*

FIRST of PLOWING: The uſe of which, though very extenſive, yet may be fully comprehended in the inſtance of breaking up lays; the perfection of which is to expoſe the greateſt ſurface poſſible, conſiſtent with the depth of the ſoil, and the nature of the crop it is intended to be put under. The depth of the ſoil, and nature of the crop, are, however, only local conſiderations; for the axiom (*expoſe the greateſt ſurface poſſible*) obtains literally, whether you plow deep or thin, broad or narrow.—But we will conſider how that comes to paſs——And the ſolution is ſimply thus: As the intention of

* WHAT is further neceſſary to be diſcuſſed on thoſe heads, will be given as ſoon as the readers are ſuppoſed ſufficienty inſtructed in mechanics to comprehend the doctrine.

of plowing is either to expoſe the furrows to the ſun and atmoſphere,* or to furniſh the greateſt quantity of mould the furrow can produce, in order to be pulverized and mixed with the ſeed: it evidently follows, that the furrow which ſhews the greateſt ſurface, *cæteris paribus*, muſt be capable of anſwering thoſe ends moſt effectually, at the leaſt expence of time and labour. However, altho' the fact is eſtabliſhed by reaſon, we will try alſo whether it ſquares with experiment.—Now, as *a a a a a a a a*, *&c.* repreſent the angular points of the furrows



on a convex ridge, 8 feet broad, properly plowed, and the curve line, *b b*, where it terminates at the back of the furrows, repreſent the width of the ridge:—the exceſs of meaſure muſt ſhew the gain of ſurface; and if you will take an opportunity to meaſure the figure, *Agricola*, I believe you will find it to be full one in four.

Agric. I MEASURE them immediately, Sir. The ridge, I find, is the ſixth part of a circle of four inches diameter, and conſequently is about two inches and one-tenth; but the angles, by actual meaſurement, I find amount to two inches and eight-tenths; the ſurface is, therefore, exactly ſeven-tenths, or a fourth of the whole, increaſed to expoſure.

Phil. IT is clearly ſo, *Agricola*; and with that advantage, the angles are better calculated to receive the influence of the ſun and atmoſphere; and likewiſe will be eaſier pulverized by the harrow, than if the ridge had been plowed with a flat ſurface. Beſides theſe advantages, there are others of particular conſequence to vegetation, reſulting from this mode of plowing: *viz.* Thoſe angular cavities at the bottom of the furrows, when the

* ONE of the greateſt advantages received by making fallow.

ridge is ſown and harrowed, by the treading of the cattle, &c. contract and incloſe a quantity of air, which (by the aſſiſtance of rain, or even dew) ſoon occaſions that ſort of fermentation which is found ſo peculiarly beneficial and friendly to vegetation; but we ſhall defer any minute inveſtigation of the rationale of this moſt intereſting particular, until we arrive at the theory of vegetation.* It alſo thickens the ſtaple in a conſiderable proportion, and thereby enlarges the paſture of the crop; and more effectually retains the impregnated moiſture or *pabulum*, for the ſole uſe of the crop, than any other mode of plowing I have yet ſeen; and is performed with eaſe to both plowman and team, when the inſtrument is good: the requiſites of which are eaſy entrance, ſteadineſs, eaſe of draught, a proper width, and a gradual and natural caſt for the ſubverſion of the furrow.

THIS, however, is giving rather too brief an account of the principles of ſuch an invaluable utenſil; but what is further neceſſary to its illuſtration, ſhall be diſcuſſed in the laſt ſection, (which is entirely devoted to the deſcription of inſtruments) and therefore, at preſent, ſhall only add, that this beneficial mode of plowing depends on the ſimilarity of the furrows, and holding the plow ſteady. For if one furrow is narrower or thicker than another, they cannot fall in their true order (as *per* figure). The ſame inconvenience muſt obtain, if the plough is not held ſteady and cloſe at heel; becauſe the heel or tail of the plough being a wedge, with its apex or point downward, when held up, the furrow it is reſiſting muſt, in courſe, lie ſhort

* AND if it is a ſtubble field, by cauſing harrows to be drawn on each ridge in the ſame order the plough-teams are to go, *i. e.* to harrow the one ſide of the ridge contrary to the other, but the horſes go the ſame way the plough-horſes, &c. do, in order to lay the ſtubble with its roots next the plough:—it will then, in courſe, be ſtowed into thoſe cavities, where it will be quite out of the way of the harrows, when harrowing in the ſeeds, and will ſoon be converted into nutriment for the crop.

ſhort of its proper place, and the groove of the furrow be left narrower; which is alſo an inconvenience. For if the cattle have not ſpace left to walk in, they will either poach the furrow, or lean too much to land, and thereby alter the line of draught.—A convenient ſpace ought, therefore, to be formed by the tail of the plough, for the furrow cattle to travel in.—What that ſpace ought to be, I am unable to fix preciſely; becauſe it, in a great meaſure, depends upon the ſize of the cattle, &c. However, I will venture to limit it as follows, *viz.*—That in no caſe it need be more than eleven inches clear at bottom; nor ever leſs than nine. The breadth and thickneſs of the furrows, *i. e.* how they ſhould be proportioned, alſo claim ſome attention.

WITH reſpect to the former, it ought never to exceed the width of the plough tail; becauſe, if it do, there is not a poſſibility of its being turned by it: and the latter ought never to exceed two-thirds of the former, otherwiſe the like inconvenience obtains.——The ſhare or ſock (unleſs on ſand or gravel ſoils) ought to be nearly (from the land ſide to the extremity of the *fin*) as broad as the furrow is intended to be made; eſpecially if it be a tough lay furrow. I ſay, nearly; becauſe the preciſe abatement cannot be aſcertained, as it requires leſs or more according to the tenacity of the ſoil. A fine lay may abate two inches; but a ruſhy lay cannot abate above half an inch.* The reſiſtance of the uncut part gives the breaſt of the plough a leaver purchaſe to wreſt the furrow to the proper angle; and the tail of the plough being at leaſt as wide as the furrow is broad, completes the work without waſte of power. By limiting the breadth and thickneſs of the furrow as above, I only mean, that thoſe proportions are not to be

* WHEN the ſoil is tough and ſpringy, the reader muſt ſee a neceſſity for making and keeping the edge of the fin ſteeled and ſharp.

be exceeded; not that they may not be abated. The latter would be equally as inconvenient as abſurd; for when the huſbandman wanted to thicken the ſtaple of his land, if it was very thin before, (perhaps only three inches) it would be impoſſible for him to increaſe it by the plough, without turning up part of the under ſtratum along with it; by which means very conſiderable diſadvantages might enſue. Inſtead of increaſing vegetation, he might totally ſtifle it, by introducing an overcharge of heterogeneous matter.—However, no ſuch inconvenience need happen, if he truly underſtand the nature of plowing, and perfections of the plough; becauſe a furrow only two inches thick, and eight or ten inches broad, if he chuſe, may be plowed: hence he may thicken his ſtaple ſufficiently, without moving a crumb of the under ſurface.

Agric. You ſurpriſe me, Sir! what do I hear? we are to thicken our ſtaple by plowing thin!—But I beg your pardon, Sir, as I am convinced I interrupted you; becauſe if we are to thicken the ſtaple by plowing thin, you no doubt meant to add, that we thin them by plowing thick.

Phil. I do not mind giving you a little ſurprize, *Agricola*; nor do I much mind your puns, for I know the good heart may have a hot head: beſides, I could not expect but there was a little of the *old* in you,* and now we have had it predominant:—but as it gains (like all its ſpecies) ſtrength by being noticed, next time I hear its foot, I will ſtep out, until you convince me it is vanquiſhed.

Agric.

* What is here meant by the *old*, is the prejudice of cuſtom, and want of attention to the nature of things.

Agric. I AM ſorry, Sir, to ſee you ſerious on the freedom I have uſed; I meant nothing but to point out the miſtake about thin broad furrows thickening the ſtaple ſoil:—and amongſt countrymen, it is uſual to crack a joke over a miſtake.

Phil. I KNOW it is uſual, *Agricola*, for ſome men to crack jokes, as you call it, when they converſe; and in general the beſt punſter gains the argument. In other companies, he who is moſt vociferous is never denied the victory; and amongſt another claſs, the richeſt in company always has an unexceptionable claim to it.—Hence it is, that principles and rational conſiderations are given to the dogs; and prejudice, chance, and obſcurity, become their ſupplanters.

I AM no enemy to a chearful diſpoſition, nor to jeſting: on the contrary, I much commend the former, and think the latter may be uſeful, when well-timed: but when a perſon is ſo attached to his joke, that for the chance of making a laugh, he will run the riſk of loſing his friend;—and when it is applied to decide matters of ſcience, philoſophy, &c. I do not heſitate to pronounce it totally prepoſterous. But it is not againſt individuals this explanation is directed, *Agricola*; it is againſt cuſtom I aim it; becauſe cuſtom governs the manners of their times. If, then, the above cuſtom be peculiar to the preſent times, or only a veſtige of the preceding ones, (as probably it is) it is doing well to ſtifle it by diſuſe. For nothing in nature can be more contrary to every ſpecies of ſedate diſquiſition, than rallery and levity.

BUT let us return to our ſubject, and view how far what I have advanced relative to thin broad furrows thickening the ſtaple ſoil, is chargeable with miſtake. Perhaps, *Agricola*, when you take a diſpaſſionate review of the matter, you may think the miſtake ought to be put to the account of another perſon.

View

View the furrows as they ſtand in the ſection of a plowed ridge I put into your hand but now,* and a very little reflection will, I dare ſay, convince you that thickening the ſtaple where it is thin, depends entirely upon plowing thin broad furrows.

Agric. I have turned to the ſection, Sir, here it is.

Phil. There now! You ſee when the furrows of a convex ridge are gathered up, (and of all the modes that are practiſed, that is the beſt for vegetation, as I ſhall ſhew you by and by) they are raiſed from lower than a horizontal poſition to rather more than an erect one, (the part which was cut by the coulter having moved more than 90 degrees, or a quarter of a circle): hence, what was breadth when the plow entered, becomes depth when it leaves it. And thus broad thin furrows (for thin they muſt be, if the ſtaple be ſuch) is the moſt effectual way of thickening the ſtaple by the plough.

Agric. Now I perceive it, Sir. I have compared the furrows to a line of bricks laid end to end, quite acroſs a ridge, and then ſetting up the two next the top like an Λ, and the others againſt them in the ſame reclining poſition, in equal numbers on each ſide;—they then undoubtedly will meaſure a greater perpendicular height on the ridge, than when laid flat; but in as much as the height is increaſed, the width is diminiſhed,—ſo if the ſtaple is thickened, the ridge muſt be narrower.

Phil. THAT is fair reaſoning, *Agricola*; what you gain in depth you loſe in width undoubtedly; and it is impoſſible it can be otherwiſe without a new creation. The adage, "none can make more of a thing than there is in it," is as pertinent here as any thing I can advance. All the AUTHOR of NATURE has left for us to do with matter, is, that we may, for our convenience,

* MEANING that in page 43.

venience, tranſpoſe it a little, if we chuſe; but to create and annihilate, are his own prerogative: and as very great convenience may be accompliſhed by abating the width or breadth of the ſtaple ſoil, and increaſing the depth or thickneſs of it,—to neglect ſuch, muſt be injurious to agriculture. For inſtance: when the ſtaple is but half the proper thickneſs, it muſt be as imprudent to put the whole ſurface under a crop, as it is to keep a mill-wheel continually creeping under an improper head of water. In both caſes, the cauſes are inadequate to produce the greateſt effects; and therefore, if capable of producing any at all, they will be but very inconſiderable. Hence ariſes the abſolute neceſſity of a theory or method in every buſineſs, to aſcertain at leaſt a common meaſure of fitneſs of cauſes to produce given effects: but, for illuſtration, we will purſue the compariſon:—when the wheel is charged with its proper quantity of water, it produces the maximum effect, every thing elſe being in perfect order. So likewiſe, when the ſtaple is of a proper thickneſs, and every other ingredient duly balanced, the crop will be the greateſt poſſible, or maximum.—Whereas, when the roots of the plants have not a proper weight or quantity of porous ſoil upon them, they can no more vegetate, than the mill can make meal, which hath but juſt force enough to overcome the friction of its own parts.

In every inſtance, therefore, where the ſtaple is too thin,* it is more adviſeable to collect it to a proper thickneſs, (where vegetation is propoſed) if even one half of the ſurface ſhould go to complete the other, than either to thicken it abruptly by heterogeneous matter, or to occupy the whole of its ſurface. Thoſe drains or bare furrows between ridges, will, in proceſs of time,

* The thinner the ſtaple, the narrower the ridges ought to be; and when the ſoil is ridged up in the manner expreſſed by the type, (page 43) it is evident the plant has the greateſt range or paſture the quantity of ſtaple thereon can poſſibly furniſh. Hence, ridging up is preferable to every other mode.

with the aſſiſtance of manure, become alſo prolific; and thus ridging land is clearly the moſt beneficial mode of laying out corn-fields, when the ſtaple is thin; as both experience and theory, do abundantly teſtify.

Agric. I PLAINLY ſee that mere practitioners are extremely liable to ſlip many notable particulars. For want of attending to the change of poſition in the furrow, from the inſtant the coulter and ſhare enter it, until the plough-tail leaves it, we have loſt the true idea of that common and uſeful operation.

Phil. Do not let that hurt you, *Agricola*; nor reckon your profeſſion ſingular: for ſo it happens to all profeſſions in one caſe or other. I have known, even in mechanics, when theory had been abandoned, the true idea ſo far defeated, that effects were taken for cauſes.* Nor are mere theoriſts at all more exempt from the like errors: *vide* "*Eſſays and Obſervations Phyſical and Literary*," where the ingenious Lord *Kames*, for want of practical knowledge in plowing, is led into a maze of difficulties. But I ſhall give you an extract of the narrative.—A gentleman recommends ſhallow plowing in the following manner.

"IT is ſome years ſince I firſt learned from gentlemen of obſervation, that the farmers in *Norfolk* and the neighbouring countries, plowed very ſhallow, and notwithſtanding raiſed good crops, and were eſteemed good huſbandmen. I could not ſee the weight of the arguments advanced in ſupport of the practice, 'till I had an opportunity of travelling through that part of the kingdom; and obſerving the management of the gentlemen and farmers, who, of late, by that means, have raiſed the county of *Norfolk* in particular from a ſtate of poverty to that of plenty and affluence. The depth they plow doth not exceed three inches, and often little more than two."

THIS

* *Vide* my Pamphlet on the Fire-Engine.

THIS gentleman, although a very candid and diſcreet remarker, either for want of attending to the nature of the plough turning and placing its furrow, or through inadvertency, omits to explain in his Eſſay, that notwithſtanding a furrow is thin or ſhallow, if it is not narrower than common, it will promote nearly as deep a ſtaple as plowing of a ſuperior thickneſs. This deficiency, and his Lordſhip's ſtation depriving him of practical knowledge in this matter, together with his extenſive *a priori* information, occaſions the following reply.

" DROPPING then authority and practice, from which ſo little ſatisfaction can be obtained, the only reſource left us is to recur to principles and rational conſiderations; which, at the ſame time, I am afraid will not carry us far; as ſeveral articles are neceſſary to be eſtabliſhed by experiments, before a concluſive argument can be formed. One capital article is, at what depth from the ſurface roots produce their ſtrongeſt effects?— Concerning this article, there is nothing aſcertained with any degree of certainty, further than, in general, that ſome roots pierce deeper than others; and that many roots, even of corn, produce vigorous effects even lower than three inches. Were arguments *a priori* to be truſted, independent of experiments, one would believe that roots are always in the moſt advantageous ſituation where Nature places them; and that accordingly a plant thrives beſt with downward roots, where Nature gives them that direction.* If this propoſition hold, to which we may truſt 'till the contrary be demonſtrated by experiments, it follows, that ſhallow plowing is proper for thoſe plants only which extend their roots horizontally. But, as beſides lateral or horizontal roots, the bulk of vegetables puſh

* HIS Lordſhip might have truſted to that reaſoning. No fair experiment ever ſhewed Nature guilty of a botch, when the progenitors were healthy and perfect.

with the aſſiſtance of manure, become alſo prolific; and thus ridging land is clearly the moſt beneficial mode of laying out corn-fields, when the ſtaple is thin; as both experience and theory, do abundantly teſtify.

Agric. I PLAINLY ſee that mere practitioners are extremely liable to ſlip many notable particulars. For want of attending to the change of poſition in the furrow, from the inſtant the coulter and ſhare enter it, until the plough-tail leaves it, we have loſt the true idea of that common and uſeful operation.

Phil. Do not let that hurt you, *Agricola*; nor reckon your profeſſion ſingular: for ſo it happens to all profeſſions in one caſe or other. I have known, even in mechanics, when theory had been abandoned, the true idea ſo far defeated, that effects were taken for cauſes.* Nor are mere theoriſts at all more exempt from the like errors: *vide* "*Eſſays and Obſervations Phyſical and Literary*," where the ingenious Lord *Kames*, for want of practical knowledge in plowing, is led into a maze of difficulties. But I ſhall give you an extract of the narrative.—A gentleman recommends ſhallow plowing in the following manner.

"IT is ſome years ſince I firſt learned from gentlemen of obſervation, that the farmers in *Norfolk* and the neighbouring countries, plowed very ſhallow, and notwithſtanding raiſed good crops, and were eſteemed good huſbandmen. I could not ſee the weight of the arguments advanced in ſupport of the practice, 'till I had an opportunity of travelling through that part of the kingdom; and obſerving the management of the gentlemen and farmers, who, of late, by that means, have raiſed the county of *Norfolk* in particular from a ſtate of poverty to that of plenty and affluence. The depth they plow doth not exceed three inches, and often little more than two."

THIS

* *Vide* my Pamphlet on the Fire-Engine.

THIS gentleman, although a very candid and diſcreet remarker, either for want of attending to the nature of the plough turning and placing its furrow, or through inadvertency, omits to explain in his Eſſay, that notwithſtanding a furrow is thin or ſhallow, if it is not narrower than common, it will promote nearly as deep a ſtaple as plowing of a ſuperior thickneſs. This deficiency, and his Lordſhip's ſtation depriving him of practical knowledge in this matter, together with his extenſive *a priori* information, occaſions the following reply.

" DROPPING then authority and practice, from which ſo little ſatisfaction can be obtained, the only reſource left us is to recur to principles and rational conſiderations; which, at the ſame time, I am afraid will not carry us far; as ſeveral articles are neceſſary to be eſtabliſhed by experiments, before a concluſive argument can be formed. One capital article is, at what depth from the ſurface roots produce their ſtrongeſt effects?—Concerning this article, there is nothing aſcertained with any degree of certainty, further than, in general, that ſome roots pierce deeper than others; and that many roots, even of corn, produce vigorous effects even lower than three inches. Were arguments *a priori* to be truſted, independent of experiments, one would believe that roots are always in the moſt advantageous ſituation where Nature places them; and that accordingly a plant thrives beſt with downward roots, where Nature gives them that direction.* If this propoſition hold, to which we may truſt 'till the contrary be demonſtrated by experiments, it follows, that ſhallow plowing is proper for thoſe plants only which extend their roots horizontally. But, as beſides lateral or horizontal roots, the bulk of vegetables puſh

* HIS Lordſhip might have truſted to that reaſoning. No fair experiment ever ſhewed Nature guilty of a botch, when the progenitors were healthy and perfect.

many roots downwards much deeper than three inches, the benefit of deep plowing for theſe plants, will appear from the following conſiderations.

" IN the firſt place, it gives room for the roots to extend themſelves according to the direction of Nature, which, it is preſumed, will contribute to the vigour of the plant. This argument goes upon the ſuppoſition, that the ſoil, as far as pierced by the plough, is proper for vegetation, either naturally, or made ſo by culture; and it muſt be kept in view, that every inch of the ſtaple comes in ſucceſſion to the ſurface, and gets the benefit of the ſun and froſt."

" IN this country, I doubt whether by ſhallow plowing, winter grain can be ſufficiently covered, &c. &c." Again,— " Now let us compare a ſhallow and a deep ſtaple with reſpect to moiſture. Where the ſtaple is ſhallow, the roots which cannot pierce the hard ground below, muſt ſpread along its ſurface. In that poſition they are drenched in water upon every ſevere ſhower; and this moiſture lies ſo near the ſurface, that it is immediately ſucked up in time of drought, and vaniſhes by evaporation.——Thus it is that the exceſſes of drought and moiſture alternately, are the conſequences of a ſhallow ſtaple."*

HIS Lordſhip gives many other inſtances (exceedingly juſt) to prove, that a ſhallow ſtaple is very precarious of ſucceſs; and to remedy it, leans entirely on deep plowing: which ſhews, that even the greateſt reaſoners, when they have a wrong *data* given, fall into perplexities; and it is another proof that practice and theory, when buſineſs is to be performed *ſecundum artem*, are inſeparable.

HAD

* OR plowing; for it is premiſed that the plough ſhall not exceed the ſtaple.

HAD the gentleman who drew his Lordſhip into this reply, at the ſame time he meaſured the depth the *Norfolk* and *Lincolnſhire* huſbandmen plowed, meaſured alſo the width of the furrows they uſually made,—the width of their ploughs above and below at the tail, and manner of ridging them up,—and quoted them,—thoſe men's practice, and my Lord *Kame*'s theory, muſt have united.

Agric. THE circumſtance of ridging up thin furrows of the uſual ſize, having the effect of thickening the ſtaple, and conſequently enlarging the paſture of the crop, although (I am now convinced) an abſolute fact, is ſo much a ſecret ſervice to huſbandry, that, in common, the operation is not underſtood. There is, in appearance, ſo great an affinity between deep plowing and a deep ſtaple, that thin plowing has been ever thought directly oppoſite.

Phil. YET, happily, the idea is preſerved. It is neceſſity, not choice, I believe indeed, which ſupports it.—For the overcharge of foreign matter which has been mixed with the ſtaple or real vegetable nidus, in countries where that happens to be thin, ſo far defeated thoſe who were ſo unfortunate as to make the attempt, that their diſappointments have been lights or beacons to others.

BUT as the bulk of huſbandmen are palpably unſolicitous of a criterion to diſtinguiſh the preciſe limit of depth they ought to plow; and as that limit is not the ſame, even in the ſame ſoil, at different times, and upon different occaſions:—— There is but too much probability they often err on the other extreme alſo. Our plan, therefore, directs that a diſſertation on

on the nature and uſe of the ſtaple, and a courſe of experiments to aſcertain the proper depth, be exhibited, in order to fix, with a due degree of accuracy, on every occaſion, a criterion for this truly important object: upon which we ſhall, next time I am favoured with your company, begin.

Agric. THAN which, nothing can be more agreeable to me, or uſeful to the profeſſion.

VI. CON-

CONVERSATION VI.

AGRICOLA.

SIR, your propoſal laſt night has really made me think this day uncommonly long, and brought me hither before the uſual time.

Phil. YOU are in perfect good time, *Agricola*;—I am quite at leiſure to proceed:——

IN order to explore the nature and uſe of ſoil, it ſeems neceſſary, in the firſt place, to take a view of the ſtructure and œconomy of the parts of plants: and as wheat is one of the moſt valuable as well as moſt common to mankind, I thought an analyſis of that ſpecies would be the moſt acceptable; and have therefore tranſcribed from my regiſter of experiments the following particulars.

October 13. PLANTED at one inch and a half deep, on a board of moiſtened earth, ſeveral grains of wheat from the ſame ear, over which I placed a thermometer; the board was placed in free air, and the thermometer did not recede above five degrees from temperate during the following proceſs.—On the 15th, at nearly the ſame hour, I took up one grain, and found it increaſed in bulk, and the fold or ſeam of the huſk opening; and when cut through acroſs the middle, about the tenth of its diameter, next the huſk, appeared yellowiſh, and had a malted taſte.——On the 16th, another grain was taken up, which was more ſwelled than the former, and a white

white ſpeck had put out at the eye. When the grain was divided longitudinally, and viewed in a microſcope, the ſtem, roots, and foliage of a plant, were very diſtinct, though folded over one another. On the 17th, another grain was taken up, the leaf of which was beginning to raiſe its point from a horizontal to a perpendicular poſition, and the roots (three in number) were deſcending apace; the contents of the grain were approaching to a liquid ſtate, and flowing to the knot from whence the ſtem and roots originated.

On the 18th, another grain was taken up, the leaf of which was quite erect, and the roots were worming amongſt the particles of ſoil, and had gotten about an inch down. On the 19th, another grain was taken up, the leaf of which was pretty far advanced, and aſſumed a ſpiral figure.* The grain was ſomething more exhauſted than in any of the former caſes, but ſtill clung to the knot out of which the roots and ſtem proceeded.—On the 21ſt, another grain was taken up, the leaf of which was juſt emerging out of the ſoil; and the roots had inſinuated themſelves near three inches into the ſoil, bending their directions to the moſt porous parts. The matter the grain contained, was now much thinner than in any of the former, and the roots and leaf proportionally augmented. Others were taken up at divers times; the proceſs much the ſame; the roots increaſed in number; and (when the matter in the grain was quite exhauſted) collected the whole nutriment the plant received from and through the circumambient ſoil. When the matter the grain contained was exhauſted, the leaf loſt its verdure, but in a few days recovered it.

* By which it gained a greater power to pierce the ſoil that covered it.—Nature is never ſhort of Art, but often exceeds her.

it. The huſk ſtill clung to the knot where it formerly delivered its contents, and prevented any thing entering the plant through that channel.

THUS it appears plants are accommodated with pure ſeminal food, until in a condition to admit a little allay; and when it is perfectly equipt, to ſubſiſt on the common diet of nature, like the fœtus excluded from the womb, is prepared to receive its new aliment through a channel capable of correcting its crudities: and being ſtamped with the propenſions, and organized like its family, attracts and aſſimilates it to its own nature and texture through every ſtage of its exiſtence.

NOW, as the abſorbent veſſels or roots, by being properly diſperſed and covered in the contiguous mould or ſoil, extract from it the neceſſary ingredients of vegetation, in a manner ſimilar to the abſorption of the lacteal veſſels in the ſtomachs and inteſtines of animals; and as the ſoil or mould is only poſſeſſed of theſe principles locally,* the mould or ſoil in which the roots are diſperſed therefore can only be conſidered as the ſtomach and inteſtines of plants.†

* THIS is very evident, becauſe ſoils, when exhauſted of thoſe principles, by being expoſed to the ſun and atmoſphere, or by being dreſſed with ſuch ſubſtances as contain them, again become fruitful, and furniſh crops until the principles are again exhauſted. A ſupply again anſwers the ſalutary purpoſe, and a few crops again exhauſt them, which muſt be reinſtated by the above means; and thus vegetation is carried on *ad infinitum*; which clearly proves the ſoil is only a receptacle for the food of plants, not the food itſelf, as Mr *Jethro Tull* unfortunately imagined.

† THE means creative wiſdom has adopted to render it capable of duly performing that office to the vegetable world, is inimitably ſimple, conſiſting chiefly in a due poroſity of the upper ſtratum, and tenacity of its baſis. The pores or interſtices ſerving to admit air and water to intermingle with the other ingredients of the food of plants, whereby the neceſſary fermentation is excited, and the tenacity or imperviouſneſs of the baſis or next ſtratum prevents the eſcape of the food, from the impulſe of gravity, &c.

Agric. IN that inſtance, Sir, there is indeed a moſt ſtriking affinity between the animal and vegetable kingdoms.

Phil. THE affinity, in that inſtance, is obvious, but not ſingularly ſo, *Agricola:* for when we admit, in general, ſenſation and motion to be the diſtinguiſhing characteriſtic of the former, and ſet apart the organs peculiar to thoſe qualities, there is an entire ſameneſs:* and as the analogy between the vegetable kingdom, and that on either ſide of it, (the foſſil and animal) is, with reſpect to the illuſtration of the preſent ſubject, very neceſſary to be exemplified, I ſhall leave the courſe of experiments, and the facts which aſcertain with ſome preciſion the proper depth of plowing for the corn ſpecies, a little behind, and proceed therewith.

NATIVE foſſils are of a plain, ſimple ſtructure, and contain no veſſels for the circulation of juices; yet do they increaſe both in bulk and denſity, while ſituated in the bowels of the earth, undetached or broke off from their reſpective ſtrata and ſuccours. Attraction and aſſimilation ſeem, therefore, to be the peculiar means of their ſubſiſtence and growth.—But as the inhabitants of the vegetable kingdom were to be the food of the inhabitants of the animal kingdom, and conſequently would be diſtorted and broke from their proper nidus, it was neceſſary to endow them with a re-productive power or capacity;

* THERE is not an inſtance to be met with in Nature, where its adorable Author introduces any new parts, unleſs ſome new office is to be performed. Hence the vegetable kingdom, as it has a farther latitude than the foſſil, has an addition of parts given to the foſſil nature. The animal kingdom being ſtill further advanced, has an addition made to both; and the rational, ſtill riſing in the ſcale, poſſeſſes an addition to them all.

city: hence, nothing ſhort of the various organization they poſſeſs, and viciſſitudes they undergo, could be diſpenſed with. And as the inhabitants of the animal kingdom are calculated to anſwer various other purpoſes, beſides food, to the rational ſpecies; to render them commodious, and the better to enable them to preſerve and propagate their ſpecies, &c. they have been created moveable ſyſtems; and conſequently furniſhed with portable ſtomachs or receptacles for food, and ſuch other parts and faculties as render them complete in their reſpective orders, and adequate to the Deſigner's intention.—Whence ſenſation and motion become the diſtinguiſhing characteriſtics of the animal from the vegetable kingdom.—Let us, however, keep our eye on thoſe particulars, while we run a further compariſon.

FIRST, then, in the analyſis of a grain of wheat, we find the embryo plant or germ placed in two lobes, in a manner exactly ſimilar to the fœtus in the placenta or cotyledones of animals. We alſo find the germ in the firſt ſtages of vegetation nouriſhed by the matter the lobes contain, through veins diſperſed amongſt it, and connected to the germ in a manner analogous to the umbilical vein of the fœtus. And as the umbilical orifice of an animal is cloſed (after it is protruded from the womb) by a ligature formed of the veins and arteries, which conſtitute the tube or *funiculis umbilicalis*, as it is called: ſo, in like manner, when the nouriſhment which the lobes contained, is exhauſted,—the veſſels which were diſperſed amongſt it, and connected to the germ, contract and draw the huſk or covering upon the orifice; and there it continues as a ligature, until the agglutination of the orifice is completed:—than which nothing can be a more ſtriking inſtance of ſameneſs.

PLANTS are alſo analogous to animals in the circulation of the juices and humours of their bodies; having air and ſap veſſels correſponding to the veins and arteries in the animal body; and the genial heat occaſioned by fermentation ſerves the purpoſes of the throbbing heart. They alſo, like animals, if their head or top is long deprived of air, after they are delivered,* die by ſuffocation: as is the caſe when ſeed is laid too deep in the mould, and when the mould has been trampled or rolled too much.

SECONDLY, From this period, until they reſpectively arrive at maturity, we find the plant and the animal under much the ſame predicament; ſometimes ſleeping and ſometimes awake; ſometimes in motion, and ſometimes ſtanding ſtill. The one moves by voluntary agency, and the other by fortuitous means, it is acknowledged; but the exerciſe a plant receives by vibrating in a breeze, probably as much aſſiſts its digeſtion and perſpiration, as a gallop aſſiſts thoſe operations in a colt, &c.—We likewiſe find them in the ſame expoſure, ſuffering together from the ſeverity of ſeaſons, and recovering alike when theſe are paſt.

WE alſo perceive them improve reciprocally by an enlarged paſture; and mutually thrive better by being kept clean. In ſhort, except in point of mere ſenſation† and voluntary motion, as before obſerved, from the womb to the ſummit of maturity, there is the moſt unexceptionable analogy between theſe worlds.

* A PLANT may be ſaid to be delivered, when it is protruded from the grain or ovary.

† AND even in this the chaſm is but narrow; for the ſenſitive plant approaches in an amazing degree.

AND Thirdly, When they have arrived at maturity, we behold, if poſſible, a ſtill greater affinity; each having their ſexes, their propenſities, their ſeaſons of copulation, and pregnancy conſequent thereon: after which their efforts are ſtill exactly ſimilar, being in both caſes principally directed to promote the growth and welfare of their young:—and although ſome animals ſurvive the operation, there are others, like the corn tribe, that die as ſoon as they have protruded their ovaries; and all of them, after they become through age incapable of reproduction, haſten to a diſſolution.

MANY other inſtances might be produced to the ſame purport; but as the above are, I preſume, ſufficient to impreſs conviction on the minds of the candid and ingenuous, I conclude it would be trifling to be more particular.

THOSE ſelf-evident truths, *Agricola*, teach us, *Firſt*, That attraction is a firſt and general principle in every ſpecies of vegetation.* *Secondly*, That in order to aſſiſt it effectually, a ſufficient quantity of ſuitable materials be placed within its ſphere. Hence it follows, that we ought to know the extent of thoſe ſpheres, and the quality of the materials which beſt ſuit the growth and completion of the inhabitants of each ſyſtem.

THIS directs us particularly to the vegetable world; becauſe native foſſils never could be intended to receive our aſſiſtance, as the very element which ſupplies us with life, and without

* IN the vegetation or growth of foſſils, it evidently militates; and in the growth of trees, plants, and animals, it alſo obtains; otherwiſe the word and operation of *abſorption* means nothing.

without which we cannot exiſt one minute,* is utterly incompatible with their growth:—and the animal creation are furniſhed by nature with powers to chuſe and bring food within the ſphere of their abſorbent or attracting veſſels. It is true we have it in our power to aſſiſt them too, when we know the quality of the food which moſt improves them, by providing it ſufficiently; but this is more a matter of œconomy and uſurpation, than natural obligation.† We ſhall therefore, at preſent, take the extent of the ſphere of attraction peculiar to the roots or abſorbent veſſels of plants, particularly thoſe of the corn genera, into contemplation. And as that ſpecies of attraction can only take place upon contact, the food or matter which they are devoted to attract or abſorb, muſt be ſo ſituated, as regularly to come into contact with them:—and this is to be affected two ways in particular. *Firſt*, By pulveriſing the ſoil or ſtaple ſufficiently, and by extending that pulveriſation or culture to a proper depth.‡ *Secondly*, By depoſiting (if it does not already contain it) a quantity of food ſufficient for the greateſt number of plants the area of the field can ſupport. Hence the nature of the crop muſt be attended to; for as wheat contains more of the conſtituent principles than barley, oats, &c. it cannot be completed with the ſame quantity of them, that barley, oats, &c. can.§ Theſe particulars, *Agricola*, viz. *Pulveriſing the ſoil ſufficiently, and depoſiting a ſufficient quantity of proper ſeed and food for the intended crop*, &c. being

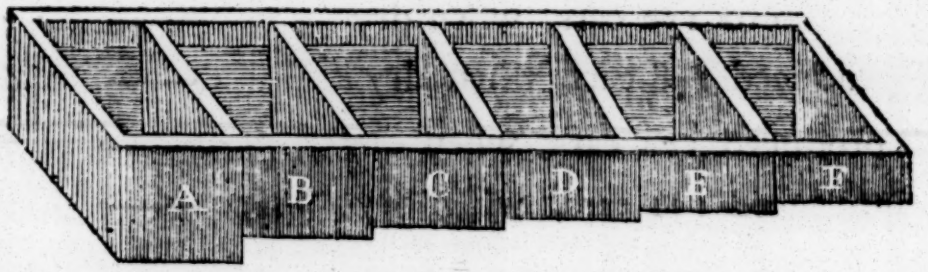
* THE air.——† This ſubject will be reſumed.

‡ *Vide* The preceding mode of plowing.

§ I KNOW no nearer or plainer general proportions (nor need there any) to eſtimate theſe by. than their exceſs of weight to their meaſure, *i. e.* as much as a gallon of the beſt wheat exceeds a gallon of the beſt barley, &c. in weight *cæteris paribus*.

being the firms of agriculture,—nothing relative thereto ought to be attended to but abſolute certainty; and therefore we ſhall have recourſe to experiment as well as reaſon, in the courſe of this inveſtigation. You will alſo, *Agricola*, be kind enough, when you think it neceſſary to have any matter further explained or repeated, to intimate your deſire.—It will, I aſſure you, give me real pleaſure.

FIRST then, to aſcertain the depth of ſtaple, and number of plants a rich black ſoil requires, when it yields the greateſt crop poſſible, *cæteris paribus*, the following courſe of experiments were carefully made. A box ſimilar to this drawing, which you may obſerve contains ſix other boxes, *A*, *B*, *C*, *D*,



E, *F*, each twelve inches ſquare, but of various depths, viz. *A* one foot, *B* ten inches, *C* nine inches, *D* eight inches, *E* ſeven inches, and *F* ſix inches deep. Thoſe ſmall boxes were all filled with the ſame ſort of ſoil, and as nearly preſſed as poſſible, (leaving the ſoil a little above the box); and in each of the boxes, *A*, *B*, *C*, *D*, *E*, 144 ſeeds of fine wheat was planted, (and

ſo much more nouriſhment or food has it taken from the ſoil, &c.——The proportions by experiment ſtand nearly thus:

Wheat	——	——	——	7
Rye	——	——	——	6½
Barley	——	——	——	6
Oats	——	——	——	4

(and in box *F*, 36 ſeeds) exactly three inches deep. The great box was let into a grove cut longitudinally in the South ſide of a ridge of the ſame ſoil, which the ſame day (*Oct.* 23) had been ſown, broad caſt, with the ſame ſort of wheat:—the box was ſet level, and its edges let a little below the ſurface of the contiguous ſoil, which was put cloſe to the box below and on all ſides:—and in this manner it remained until harveſt:* and the reſult of each was as follows:

	(Apoth. weight)	oz.	gr.
Box *F* produced 112 fine ears of corn, weight when threſhed and miln dry	——	5	13
Box *E* produced 137 lean ears, when dry	——	4	1
Box *D* produced 152 ears, when dry	——	5	19
Box *C* produced 148 ears, when dry	——	6	3
Box *B* produced 154 ears, when dry	——	7	11
Box *A* produced 151 ears, when dry	——	7	2

THE boxes *F*, *C*, *B* were firſt ripe.—Box *A* the largeſt ſtraw.

THE field a good crop, but inferior to the boxes.

THE box continued in the field with its ſtubble in the ſame poſition, until the field was to be plowed for oats. The ſtubble was then pulled up, and the produce of each box burnt ſeparately, and the aſhes mixed with the ſoil of the box it reſpectively

* THE boxes were ſufficiently cloſe to hold all moiſture which deſcended upon them, but had none added by any other means. When the field was rolled, care was taken to keep the horſes from trampling them; but the roller had leave to act on their ſurface in common with the other parts of the ridge.

tively belonged to; and at the ſame time the ſoil was turned upſide down in each box, and left until the field was ſown, which was then plowed. When the field was ſown, the boxes were alſo planted with oats, as follows:

IN each box 144 fine oat ſeeds were planted at two inches and a half deep:—the box was left to take the fate of the field, and at harveſt produced as below:

Box *A*, 144 perfect ſtalks, which yielded ſix ounces of dry oats.

Box *B*, 144 perfect ſtalks, which yielded ſix ounces and fourteen grains of dry oats.

Box *C*, 144 perfect ſtalks, which yielded five ounces and ſix drachms of dry oats.

Box *D*, 144 perfect ſtalks, which produced five ounces and eleven grains of dry oats.

Box *E*, 144 perfect ſtalks, which yielded four ounces and ſeventeen grains of dry oats.

Box *F*, 97 perfect ſtalks, which only yielded three ounces and ſeven drachms.

THESE, *Agricola*, were the reſult of the above proceſs; from which, I preſume, the following concluſions may be deduced.

FIRST, As the produce of box *B* (ten inches deep of mould or ſoil) was better, both in the wheat and oat crop, than the produce of box *A*, which was twelve inches deep, and both

ſeaſons, where the experiment was made,* free of peculiarities, —I conclude that no ſtaple need exceed twelve inches deep, to produce the beſt crop poſſible of wheat, oats, (and we may venture, upon the authority of analogy, to add) rye, barley, peaſe, and even beans.§

SECOND, And as the produce of box *D* (eight inches deep), box *E* (ſeven inches deep), and box *F* (ſix inches deep), were all inferior to box *A*, *B*, and *C*, although box *F* had the advantage of being thin planted,—That a ſtaple any thing ſhort of nine inches deep, is inſufficient to ſupport a courſe of crops in the beſt manner.†

THIRD, That as the produce of box *F*, which had only 36 ſeeds planted in it, and contained 1-7th leſs ſoil than box *E*, (which had 144 ſeeds planted in it) produced more good wheat at harveſt than box *E*,—That thin ſowing, or planting, ſuits a thin ſtaple beſt. This concluſion is ſtrongly corroborated by the produce of box *F* when under the oat crop, as well as its reſult under the wheat crop: for when it had an equal number

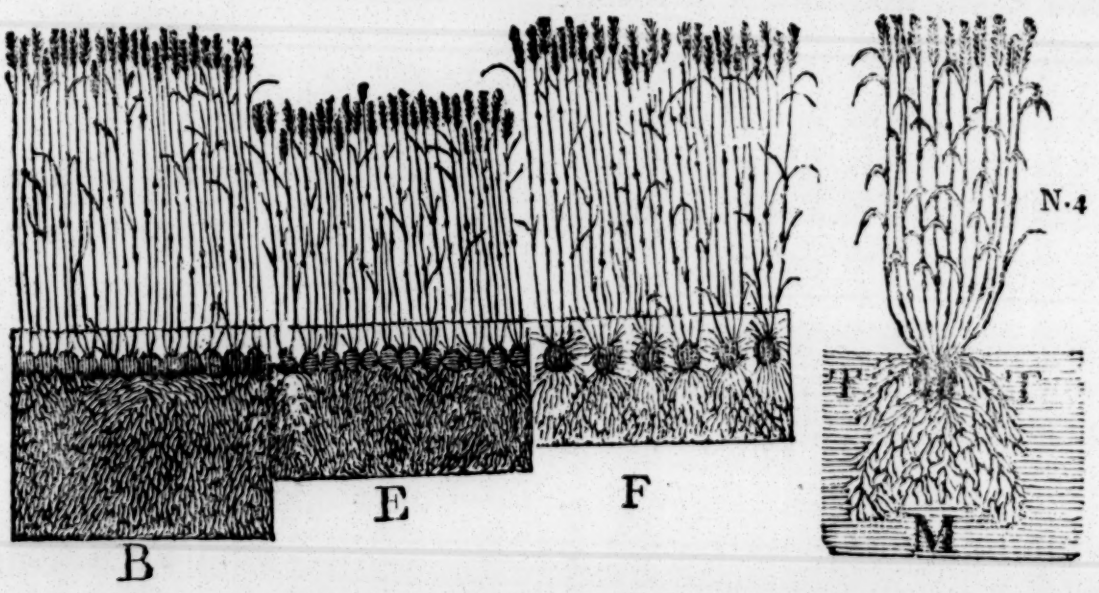
* 1762 and 1763, in *Northumberland*.

§ WHEN the ſtaple is cultivated further than the material abſorbents reach, the nutritive juices eſcape them; hence a famine may enſue in the neighbourhood of plenty. For as the ſoil (as before aſſerted) is to plants what the ſtomach and inteſtines are to animals,—by making it too large, an abſolute gluttony will inevitably follow; the never-failing concomitant of which is leanneſs. And as that deteſtable diſeaſe in the animal ſtomach is as often the reſult of imperfect valves, as the effect of too large a reſervoir; ſo likewiſe a famine amongſt vegetables may, and often doth happen by the under ſtrata being too porous.

† IT is not meant by this concluſion that the ſtaple muſt unavoidably be nine inches thick at leaſt, in a horizontal poſition, when broke up; but that when ridges are formed, that their prime parts ſhould be made (by the plough as before intimated) to bear that depth.——The manner of equipping the plough for that purpoſe having ſomething peculiar in it, cannot be properly explained until the deſcription of plows is given in ſect III.

ber of ſeeds planted in it with box *E*, its produce was much inferior: which naturally ſuggeſts the following concluſion, *viz.* That the roots or abſorbing veſſels of the 36 ſeeds, by having a convenient ſpace to diverge in, came to ſuch maturity and ſtrength as gave them ability to collect a ſufficient quantity of food, to ſupport a healthy vegetation in the ſtalks, &c.—Whereas box *E* being ſtocked with four times the number of plants, the roots were ſo circumſcribed below and on each ſide, that they were unable to convey proper quantities of food to ſupport ſuch a ſtate of vegetation.

BUT I do not deſire you to rely wholly on argument for this fact, *Agricola*; it admits of ocular demonſtration; and therefore caſt your eye on this ſection of the box *B*, *E*, and *F*,



taken upon a ſimilar experiment, when the ears were juſt out of the leaf. You cannot but obſerve in box *E* the inconvenience that muſt inevitably attend ſuch a congeries of plants huddled promiſcuouſly root upon root, and branch upon branch.——So many different intereſts, (if I may riſk the expreſſion) in ſo ſmall a territory, muſt well nigh ſtarve all, not-

withſtanding there may be a quantity of food ſufficient for all. For the roots of one plant twiſting in all directions round the roots of another, muſt unavoidably injure both; as the contact occaſions a contraction of the tubes or veſſels of both, and likewiſe galls their ſurfaces; than which, nothing but mere ſtarvation can be a greater detriment.* We have a ſtriking inſtance of that ſort of inconvenience in the diſtreſs of the moſt healthy and vigorous growing trees, when they become infeſted with ivy, convolvulus, &c.——If then the ſtrongeſt trees are found to languiſh, by a ſlight conſtriction of their moſt robuſt parts, there can be no manner of doubt that a tender plant muſt ſuffer much by having its vital parts encumbered and diſtorted.

THE produce of box *E* being ſuperior to box *F*, when they were equally ſtocked with plants while under the oat crop,—ſhews that there was food enough, and therefore the ſhort produce of the wheat crop could not proceed from a deficiency of that kind. If thick ſowing or planting is attended with inconvenience in a thin ſtaple, there is very good reaſon to conclude it is no advantage in a deep one:—for although the roots may penetrate deeper, yet they are equally clogged and haraſſed with a lateral compreſſure, and interference of rival tubes.—Being as far convinced this was a fair concluſion, as reaſon and analogy could certify,—I next appealed to experiment, to render it irrefragably certain or otherwiſe. For which purpoſe two boxes, each twelve inches the ſide of the ſquare, (inſide meaſure) and ten inches deep, were filled with an equal quantity of rich ſoil, and placed in the field in a manner ſimilar to

* FROM experiments I am convinced, that wounds in the attracting veſſels are exceedingly injurious to the growth of plants; and that it is in that way mineral ſalts, &c. effect their ruin.

to the boxes heretofore mentioned. In one box 144 ſeeds of wheat were planted three inches deep:—in the other 36 ſeeds of the ſame wheat were planted, alſo at three inches deep:—the reſult as follows:

THE box which was planted with 144 ſeeds, produced near half a pound; and the box which was planted with 36 ſeeds, produced as near three quarters of a pound. This reſult in courſe pointed out the neceſſity of aſcertaining the proper diſtances of depoſiting the ſeeds of corn: hence great variety of experiments have been accordingly made. The certainty they pointed to was, that the richer the ſoil, the more plants it ſupported, and *vice verſâ:* and when there were not ſufficient of original plants, bounteous Nature ſtretched every nerve to furniſh them; producing ſometimes twenty or thirty ſtalks rather than admit of a void. And theſe ſtalks which tillered from the originals, produced more and better ſeeds than the originals themſelves, *cæteris paribus*. It ſeems therefore very proper to let her act her own part;—it is for certain a ſaving of ſeed: and if the original ſtalks are at no greater diſtance than that the tiller ſtalks of one original, when full grown, juſt approach the tiller ſtalks of another original, there can be no deficiency.*

IF

* IN good rich ſoils I have found three inches the moſt proper diſtance for a full crop; the whole ſurface being ſtocked with ſtalks at harveſt as cloſe as they could grow.——In poor land I have found it moſt adviſeable to ſow thicker, becauſe the original ſtalks do not tiller ſo well, let the ſpaces be ever ſo great:- hence, to have a full crop, there is a neceſſity to ſow a little cloſer. I ſay a little cloſer only; for when brought to the diſtance of the ſtalks in box *E*, in cut p. 67, the ſame inconvenience will obtain with them as with it.——It is the culture of wheat we have now in view, and as it requires land to be in good heart to yield a good crop, it is neceſſary to be obſerved, that it will always be an error to put poor ill-cultivated land under wheat, whether it be thick or thin ſown, &c.

IF huſbandmen will, therefore, previous to ſowing or planting the field, make a fair eſtimate of the ability of the ſoil, and full allowance for the ſeverity of ſeaſons, and other contingencies; and adopt a method of depoſiting the ſeeds of grain at ſuch diſtances and depths as beſt ſuit their reſpective ſoils, &c. (which we hope hereafter to point out) many thouſand quarters of grain might be ſpared in ſeed, and a larger quantity reaped at harveſt, than if thoſe thouſands had been ſown:—the preciſe diſtance depending on the condition and culture of the ſoil, it is impoſſible to be aſcertained, unleſs thoſe are premiſed. Every occupier of land muſt, therefore, experiment for himſelf, if he rationally expects to acquire proper information relative to this important matter. And if they proceed agreeable to the method which will be hereafter laid down, they need not, we hope, ſtop ſhort for want of data.

Agric. IN the courſe of theſe intereſting experiments, I obſerve you have, in every inſtance, depoſited the ſeeds at three inches deep:—the proper depth for depoſiting the ſeed being held with us a very material affair, I ſhould be glad to know whether that is the general criterion; for I am perſuaded it depends too much on circumſtances to be without exceptions.

Phil. YOUR remark is too important to die with the evening, *Agricola*; I ſhall therefore, when you next favour me with your viſit, endeavour to explain the rationale of that operation from the reſult of experiments, and fix the criterion (which

(which, as you well obſerve, can never be ſo particular as to be without exception) with the greateſt preciſion analogy and facts enable us:—and for the preſent, let us ſtep to the other apartment, and ſilence that tinkling monitor,* where I hope we ſhall, as uſual, have occaſion to think well of *Soror*'s culinary philoſophy.

VII. CON-

* THE bell ringing for ſupper.

CONVERSATION VII.

PHILOSOPHUS.

YOU are well come, *Agricola*;—I have caſt my regiſter of experiments, and here they are, which reſpect the depth of depoſiting the ſeeds of corn.

October 23. PLANTED, at three inches diſtance, ſixteen ſeeds of wheat, taken from one fine ear.

Two were depoſited at exactly one inch deep;* two at two inches deep; two at three inches deep; two at four inches deep; two at five inches deep; two at ſix inches deep; two at ſeven inches deep; and two at eight inches deep. The land was in good heart, and finely pulveriſed or meliorated one foot deep, on purpoſe for the experiment; the ſituation facing the South, and in the middle of an open field.—At harveſt, the reſult was as follows: *viz.*

THOSE depoſited at one inch deep were almoſt turned out of the ground, had tillered very little, and the ears were few, and the grain lean.

DITTO depoſited at two inches, tillered largely, and ſtood upright on the ground, were well filled, and excellent grain.

DITTO

* DEPOSITING ſeeds at a given depth, by way of experiment, &c. may be exactly and expeditiouſly performed, by having dibbles with a croſs-pin or ſtop put at the ſame diſtance from the point that the ſeed is deſigned to be depoſited, and the dibble thruſt exactly home to the ſtop or croſs-pin.

DITTO depoſited at three inches deep, tillered more largely, and had ſtronger ſtraw and larger ears, ripened well and ſeaſonably.

DITTO depoſited at four inches, nearly the ſame.

DITTO depoſited at five inches, did not tiller ſo much as thoſe depoſited at four inches, neither did they produce ſuch ſtrong ſtalks, nor ſo much grain.

DITTO depoſited at ſix inches deep, tillered leſs, and did not ripen ſo well as the above.

DITTO depoſited at ſeven, produced only one ſtalk; it ſhrivelled to nothing before midſummer.

DITTO depoſited at eight inches deep, never came above ground.

THE reſult of this experiment, and a variety of others, made at different times on different ſeeds,* and in different ſoils,† the particulars of which I ſhall not here trouble you with, *Agricola*, give me reaſon to conclude, that from two inches deep to five is the greateſt latitude which this operation admits of. The lighteſt ſoils and drieſt ſeaſons require the greateſt depths to be uſed; and wheat, of all the grains, admits of being depoſited deepeſt. When the ſoil has been lately broke up, and rich; or is a very fine ſandy loam, &c. full of manure, (and withal a dry ſeed time) I have found four inches the beſt depth; but in general, three inches, in my experiments, has anſwered beſt.

* WHEAT, rye, barley, oats, peaſe, and beans.—† Loam, clay, ſandy, moſſey, gravelly, &c.

AT that depth, the firſt valve or knot of the tillered ſtalks is commonly juſt even with the ſurface of the ſoil in the ſpring; and when that is the caſe, provided the ſtalks are not hampered or crowded, have food enough, &c. they ſend out numerous roots or abſorbing veſſels, in the manner of thoſe ſeen in the cut M, page 67 at T T. Theſe roots prove of vaſt importance to the crop, by giving the ſtalks ſtability and food, even when the ſeverities of winter have well nigh demoliſhed the ſeed roots. The firſt they effect, by diverging from the knot to the land, at the beſt angle their ſituation admits of; and thereby prop it on one ſide, and guy it on the other:*— the latter by directing their minute ramifications through that part of the ſoil the winter roots had not exhauſted; and where the moſt immediate and powerful influence of the atmoſphere obtains.† And as the leaves and ſtalks at that ſeaſon protect them from the inconvenience of the approaching droughts, ſo doth this keeping near the ſurface enable them to eſcape the ill effects of too much moiſture:—in ſhort, they may, in many inſtances, with great propriety, be deemed the ſalvation of the crop; and therefore whatever contributes to promote and ſuccour them, demands our utmoſt attention.

Agric. I BEGIN to ſuſpect they are the occaſion of wheat all on a ſudden, in the ſpring, after we have had ſome mild weather, getting ſuch a deep green colour, broad leaf, &c.

Phil.

* THOSE that chuſe to attend to this pleaſing and important operation in Nature, will find theſe knot roots diverge always, when uninterrupted, in an angle of 45 deg. The beſt mechanic upon earth cannot therefore exceed the mechanical operations of vegetative Nature in her own province.

† NEAR the ſurface.

Phil. YES, *Agricola*, it is the occaſion of that too, as ſure as a mouthful of new teeth is the cauſe of a horſe recovering his fleſh, that had been almoſt famiſhed by want, unable to grind his fodder with his old ones.

Agric. I HAVE ever conſidered that change of colour, &c. in ſpring, as the ſureſt indication of a reſpectable crop; but never could aſſign any particular cauſe for it; conſequently unable to preſcribe any means to forward it.——Experience has indeed taught us, that rolling in ſpring has promoted it, but this we imagined was effected by giving the roots a proper firmneſs, which the winter's froſt had deprived them of.

Phil. A MOST rational concluſion, *Agricola*; and ſuch a practice judiciouſly timed, has great and good effects. It was by harrowing and rolling wheat in ſpring that I firſt perceived this effort of Nature.——The wheat had been ſown under furrow, the ſoil light* and dry; the winter proved wet, and the ſpring dry, which, notwithſtanding the lightneſs of the ſoil, occaſioned a bratted or ſealy ſurface; to take off which, I had it done over with very ſhort-tined (or teethed) harrows.—Soon after this, the wheat (which was very thin and ſickly) tillered and thickened much; which afforded conviction to *Servus*, that his objection to harrow was an error. However, a froſt ſetting in, occaſioned a ſevere relapſe:—as ſoon as the air became mild, and the field dryiſh, it was gone over with an oak roller, (the cylinder of which was ſix feet long and fifteen inches diameter, the carriage of itſelf light, and without any load on it): this ſunk the ſtalks a little into the ſoil, and laid

* THIS condition of ſoil is in ſome parts of *England* called a plumb ſtate.

them horizontal. In a few days, the weather holding fine, I perceived roots ſtriking the ſoil from the under knots of the tiller ſtalks, which afforded me much ſatisfaction for the preſent, and in due time brought a plentiful crop. This diſcovery and ſucceſs have ever ſince made me exceeding ſolicitous of coming at a method to promote knot or crown roots; and never have I ſucceeded better in that purſuit, than when the ſoil was in good heart, well freed of weeds, the ſeeds depoſited from two to three inches deep, and as much apart, and treated in the ſpring as above recited,* and as follows: *viz.* When the autumn proved favourable for ſowing wheat, ſo that the plants before the winter were large and ſtrong, I have found it of great utility to ſtrew as much good ſoil upon them as nearly covered both ſtalks and leaves.† When the autumn doth not ſo accommodate the huſbandman, the proceſs anſwers to great advantage in ſpring, either before or after rolling.

Agric. BUT, lack-a-day, what are we to do for ſoil, and how is it poſſible to lodge it conveniently to anſwer the purpoſe, Sir?

Phil. KEEP heart, *Agricola*; I have an antidote at hand for your *ne plus ultra*. Now, ſuppoſe your ridge to be ten or twelve feet wide, I ſhould reſerve fourteen or ſixteen inches in the

* THESE experiments I thought it my duty to regiſter with due care, and I have as faithfully recited them; for there is nothing on this ſide of perdition I ſo much abominate as unfair experimental repreſentations; notwithſtanding which I ſincerely recommend a recapitulation. Different circumſtances may occaſion different reſults; and ſuch aſcertained, will reflect new light and new advantages upon the ſcience.

† THERE is no occaſion to roll in ſpring when this is done in the beginning of winter; unleſs it proves an exceſſive froſty winter, or when the ſoil is light, new, and very rich.

the very middle of it, for the above purpoſe :—I own the propoſal may at firſt ſight alarm you, *Agricola*; but when you have diſpaſſionately reviewed every circumſtance, I know you too well to make a doubt of your compliance. In the common way, and indeed there is no way of taking up a ridge with the plough that you ſhall not either turn one furrow upon another, and thereby ſet up a comb, which prevents any ſeed halting on the middle of the ridge, if ſown broad caſt ;— or if that is not done, twelve or fourteen inches of land is left unplowed, and two furrows thrown upon it, through which a notable crop of weeds generally makes rapid progreſs :—therefore to take the ſoil from ſuch a ſituation, has leſs detriment in it than at firſt ſight it is poſſible to admit. Beſides the advantages it affords the crop by ſhelter and nutriment, it alſo greatly facilitates the circumſtance of tillering, and ſtriking knot or crown roots, by holding the ſtalks for ſome time in a reclining or horizontal attitude; and then it is (if food is to be had) that the ſtalks will be ſo gorged, that, to employ the influence, dame Nature is under a neceſſity to form new ſtalks; for ſhe will not be guilty of waſte. And as we have, by laying the original ſtalks in a reclining or horizontal poſture, obliged her to increaſe her apartments:‡ She is alſo under a neceſſity, bye-and-bye, of forming new roots to ſupport the coloſſus; for when the ſtalks again recover their erect poſition, the whole would be ſoon overſet, as well as ill ſupplied with food, were

‡ THE reaſon of this exceſs of food flowing to the ſtalks, when laid horizontally, &c. is, the capillaries communicate it in ſuch an attitude, upon the principles of an aqueduct or canal, not merely by the attraction of the ſides of the tubes, as is the caſe when the ſtalks are erect. Hence it is that fruit-trees, after they have been barren many years, when laid horizontally, &c. begin to yield again; and that hedge-wood, &c. when plaſhed, notwithſtanding cut nine-tenths through, ſuccour numerous large ſhoots, &c. &c.

were they not inſtantly propt, and nouriſhed by crown roots. Thus dame Nature may be cajoled into full employ; and ſhe is ſuch a faithful drudge, that only put the materials ſeaſonably in her way, and we need not fear but the end will be accompliſhed in due time. The trench on the top of the ridge will be very convenient when the ridge is next plowed, as it keeps it perfectly circular by receiving the two firſt furrows, which in the uſual way muſt either lay one upon another, and erect that waſteful comb before mentioned; or occaſion a ſpace to be left unplowed, as before hinted, if the plough work its full depth the two firſt bouts, as is evident from the figure, page 43; where the two firſt are only angular ſlices, inſtead of oblong furrows: and in ſeed-time, before the trench is made, the unſown ſpace (of fourteen or ſixteen inches) furniſhes an excellent path for one of the harrow or drill horſes, and the other one walks in the water furrow; ſo that the ſown ridge is exempt from the terrible havock of ſeed and ſoil that is unavoidable in the common huſbandry when ſeaſons prove wet.* In ſummer the trench will alſo be found exceedingly convenient; in as much as the perſon who picks the weeds on that ſide of the ridge, by walking and ſtowing the weeds therein, will neither break down the ſtalks, nor cumber them with the amputated weeds.

Agric.

* In wet ſeaſons, (and ſuch do frequently happen) the ſeed on which the harrow horſes tread, never vegetates; and the hole left, if the ſoil is clay, becomes a reſervoir for water all winter; than which nothing can be more deſtructive to both the preſent crop, and to the condition of the ſoil. And when the crop requires rolling, who can but obſerve with regret the vaſt deſtruction the horſes' feet then occaſion, by poaching the ſown ridge, &c. all which will be remedied by this mode of cultivation.

Agric. I REALLY had not an idea of the method you have now explained for furniſhing a top-dreſſing of ſoil.——To take the top of the ridge for that purpoſe,—had you not inſtanced a number of undeniable inconveniences which attend its being cropt in our huſbandry, and the many conveniences which attend employing it as above directed, particularly its being converted into a path for the horſes when harrowing and rolling;—I am not certain whether I ſhould not have thought it a ſtrange innovation; eſpecially as you have not mentioned any comparative advantage in the crop. But if that waſteful and unſightly practice of poaching the ridge when harrowing and rolling it, can thereby be prevented, and a convenient path for the weeders to travel in, and ſpace for the weeds to diſſolve in; and beſides, ſuch a top-dreſſing as will afford the crop ſhelter, and nutriment be procured, at the expence of a furrow of land, I doubt not but the ſcheme will be adopted; for my part, I aſſure you, Sir, I purpoſe ſo to do the firſt opportunity.

Phil. YES, *Agricola*; where ridges are ten or twelve feet wide, (and that ſize is exceedingly commodious for all the operations of huſbandry) no horſe need ever ſet foot on the land when harrowing; for as two horſes are very able to draw ſuch harrows as will completely cover from the water furrow to the top of the ridge, you may, by making the maſter-whipin or ſwinging-tree exactly as long (from hook to hook) as the half ridge is broad; and by putting a ſtretcher of the ſame length, between the horſes (faſtened to their bits) oblige them to tread always one in the water furrow, and the other on the ſpace left for top-dreſſing: and as the horſes will then have firm ground to tread on, they will do the work with leſs fatigue than the common way occaſions.

AND

AND when the ridges are to be rolled, the horſes may travel in thoſe paths, provided the roller has double ſhafts, and the middle of each pair of ſhafts correſpond therewith: all which may be done at an eaſy rate.*

Agric. I CLEARLY underſtand you, Sir; and am ſo delighted with the idea, that I long for an opportunity to realize it.

Phil. YOU can have no opportunity, *Agricola*, of making an experiment until next autumn; however, in the interim, you may be forming a few fallow ridges to this mode. But mind, I do not adviſe you to embark largely in this, nor any new ſyſtem, until you have proved it ſafe and beneficial by repeated experiments, notwithſtanding mine have been exceedingly ſatisfactory and advantageous.† For ſhould you at once put your whole crop under this culture, and any unfavourable appearances militate, it might occaſion too much anxiety: beſides, every deviation from an eſtabliſhed practice, however flattering its proſpect (to do it juſtice) ought to be introduced with precaution, and eſtabliſhed by gradual advances.

IT only remains now to inform you in what manner the trench is cut, and its contents diſtributed; and at what expence. You will therefore remember, *Agricola*, that I have found it beſt performed in the following manner:—Firſt, make one bout with a narrow plough, the coulter of which muſt cut to within

* THE harrow, drill, and roller, proper for this mode of huſbandry, will be deſcribed in the laſt ſection, and their figures delineated in plate third.

† A RIDGE huſbanded in the above manner, yielded near double the quantity of good wheat that a ridge of the ſame ſize, ſoil, &c. did, huſbanded in the uſual way.

within three inches of the plants on either ſide, and ought to cut very clean, otherwiſe the plants may be incommoded thereby. The plough muſt alſo be held up with the right handle, in order to give the trench a proper ſlope; and if it work as deep as the trench is intended, the manual labour will be conſiderably abated on that account.

AFTER the trench has been ſcored out in the above manner, a perſon begins at the lower end* of the ridge with a light iron ſhovel, of a convenient width, to take the crumbs from the bottom of the trench; which, together with the whole contents, he muſt ſtrew regularly from the ſides of the trench to the water furrows. If the trench is fourteen inches wide at top, eight or nine inches deep,† and ten wide at bottom, a ridge of ten feet wide will be thereby dreſſed an inch deep: and the whole expence, in any ſoil, will fall within 3 s. 6 d. *per* acre, done in a neat manner;‡ in ſome not more than 2 s. 6 d.—I have already given you an idea of the advantage; and diſadvantageous I never found it; and therefore I reſt it with you, firſt to try, and then extend it as your own experience ſhall recommend.

WHAT we have advanced hitherto, *Agricola*, relative to plowing, I own reſpects practice more than theory; but as what has been advanced, ſeemed neceſſary to make good a de-

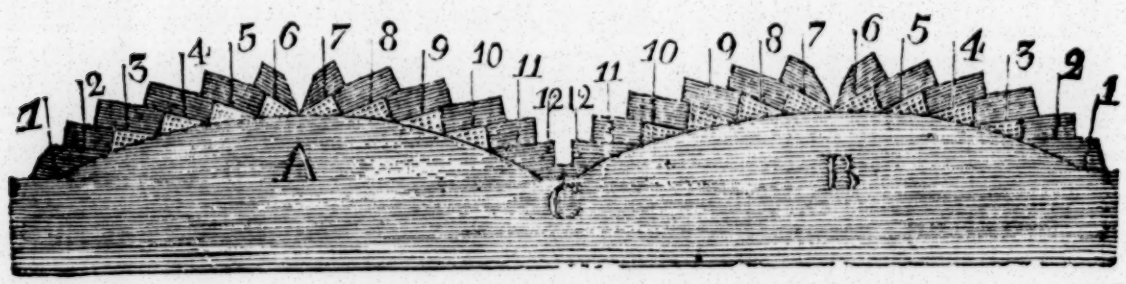
* WHETHER this be performed in autumn or ſpring, the weather ought to be dry and mild, and the ſoil in a meliorated ſtate.

† BY no means exceed the depth of the ſtaple.

‡ A MASTER's eye is highly neceſſary; for if the ſoil is not regularly ſpread and finely broke in the trench before it is caſt, it will be inconvenient.

ficiency in practice, I doubt not of your readily excuſing the digreſſion, and permitting me to proſecute it a little further.

Now as harrowing and rolling both reduce the ſurface into a leſs area than the plough doth; and as the largeſt ſurface or area is beſt calculated to receive the riches of the atmoſphere, it follows, that the ſoil ſhould, as much as poſſible, lie under the impreſſion of the plough; and that the impreſſion of harrows and rollers ought to be altogether temporary.‖ Hence, as ſoon as the ſtubbles are picked, &c. all land that has been under the top-dreſſing culture, ought to be ridged up, as in cut, page 43; and that which has been under ſpring corn, laid in form of the ridges *A* and *B* in this cut; taking care to water furrow them (whether interded for fallow or bearing the enſuing year) as repreſented at *C*.



Agric. THAT will greatly increaſe our labour, Sir; for I foreſee you'll think another plowing neceſſary to be given before the ſeed is ſown, if even intended for ſpring corn.

Phil.

‖ THE drill intended for the top-dreſſing huſbandry finiſhes the ridges exactly as the plough does. What is meant here by the impreſſion of the harrows and rollers being temporary, is to be underſtood in reſpect to the preparation of the land before ſown.

Phil. You foreſee quite right, *Agricola*; I certainly would, in the ſpring, as ſoon as the land is dry, firſt harrow,§ and then plow it in the order of cut, page 43; taking care, if the winter's froſt and action of the harrows have not quite reduced the furrows of the autumn plowing, to make the coulter cut them in the middle, as the lines 1, 2, 3, 4, &c. in this cut repreſent.*

MR

§ HARROW in the morning as much as will ſerve plowing for the day.

* THOSE two modes of plowing are all that are neceſſary; for by uſing them alternately, they change the ſides of the ſoil the moſt effectually to the atmoſphere.—They alſo preſerve the eveneſt ſtaple, and afford a greater ſcope for the roots of plants, eſpecially thoſe of the corn kind, than a plane or flat ridge can do, every thing elſe being the ſame. I am aware that ſome people have, and may attempt to invalidate this opinion, by ſuggeſting that there can only be the ſame number of parallel or perpendicular lines, even in a circle, that there is in a plane, whoſe baſe is equal to the diameter of that circle. The ſuggeſtion is plauſible, I own; but until ſuch men can make it appear, *bona fide*, that a line laid over the dome of St *Paul*'s, does not, in length, exceed a line ſtretched from its one ſide to the other; or that the great *Hall-down* in *Devon*, *Chiviot* in *Northumberland*, *&c.* were they as good ſoil, and every other circumſtance equal to plains of the ſame area of their baſes, that even then thoſe mountains would not afford more paſture than thoſe plains; I hope no huſbandman will attend to their ſophiſtry. Is it not evident to the moſt ſuperficial eye, that the materials of an arch are larger at top than at bottom? And is it not equally evident that the roots of corn do not, in their full magnitude, (nor indeed at any rate) penetrate to the depth of the baſe line of the ridge, and therefore cannot be affected by the contraction which there obtains.—Neither do their ears, like the tops of trees, require ſo great a ſpace as their roots. It is alſo well known, that if the ridge is circular, the ears of corn will be arranged in a circle alſo; and therefore give the ſun and air freer intercourſe than a plain admits of; nor can it be diſputed but that circular ridges lay land drier than flat ridges, and are alſo leſs liable to be affected by drought.

THIS, however paradoxical to the unexperienced, is clear to men of experience: for ſoil that has not been ſaturated with water in winter, does not open and cake ſo much in ſummer by drought, as that which has been ſo drenched; conſequently the dews (which are the only ſupplies of moiſture in droughty times) enter with great

MR *Jethro Tull* found frequent plowing ſo ſerviceable, that he conjectured land needed no other aſſiſtance to keep it under a conſtant ſucceſſion of crops by his drill huſbandry.—It did not altogether anſwer; that I beg you will take along with you, *Agricola*; but had he connected manuring with it, he certainly would have ſucceeded; but by ſeparating them, (with ſorrow do I mention it) he loſt an eſtate! The reſult of this gentleman's uſeful (tho', to himſelf, dear-bought) experience, tells us, and theory does the ſame, that the land or ſoil is not itſelf the food of plants, but the receptable of the various ingredients ſuch food is compoſed of, as I have formerly intimated.——Now, in order to aſcertain when it is moſt diſpoſed to receive ſuch ingredients, and beſt able to retain and prepare them, &c. it ſeems neceſſary that we ſhould, in the firſt place, know what they are, their qualities, &c.

Agric. A MOST gladdening propoſal, Sir; but it is now not only late, but ſome minutes paſt the time I appointed to be with *Servus*.

Phil. BESIDES, as you ſeem ſo fond of what is propoſed, I think, for the digeſtion of what you have already heard, we had beſt defer it 'till next meeting.

VIII. CON-

facility. And if it do not crack and open as much, neither will it dry ſo faſt;—otherwiſe the botaniſt who perforates his rhubarb to make it dry ſooner, is roundly miſtaken. In a word, the convex-ridge has, when compared with the flat or plain ridge, every advantage, except that of being plowed in leſs time; and this is well repaid, elſe ten is not more than nine: for full as much will the gain of crop be, *cæteris paribus*. Hence the gentleman who purchaſes a platform deep ſtaple of 90 acres, may turn it into 100 by the plough, and at the ſame time give it all the above-mentioned advantages.

CONVERSATION VIII.

PHILOSOPHUS.

THE ſubject propoſed laſt night for our preſent contemplation, fortunately for us, has long engaged the attention and abilities of many learned and ingenious gentlemen, who, with the aſſiſtance of the art of chemiſtry, have made great progreſs in that important inveſtigation.

Agric. THE propoſal inſpired me with ſuch ardour, that I have been ever ſince forming conjectures in my own mind what this general food ſhould be. I have really hit on one thought which I cannot forego——it is ſo pleaſing, and (to myſelf) ſo convincing——

Phil. BRAVO, *Agricola!* now you are in the very ſpirit of philoſophiſing, and conſequently of being bettered by theory: but I long to hear the dernier of your reverie.

Agric. BEING convinced that the ſoil is no more than a ſtomach to the vegetable creation, and no other viſible matter being within their reach, but water and air, that I know of,—I concluded thoſe muſt be the food of plants.

Phil. IT is a very pertinent concluſion, *Agricola*; and is as near the matter as the primitive enquirers themſelves were; for I ſuppoſe what you mean by air, is every thing the atmoſphere contains, that is ſuitable food for plants.

Agric.

Agric. Now you make me happy, Sir; for by your hinting that the air is cloathed with various kinds of matter, I am ſatisfied that it may contain ſuch materials as enable plants to aſſume the conſiſtence and texture we view them in;—but what theſe are, I could form no idea.

Phil. YOUR conjectures, *Agricola*, equally aſtoniſh and pleaſe me:—How equally hath the Parent of the Univerſe dealt the bleſſings of rational diſcernment! if they are not equally improved, it clearly is the effect of inattention:——*Boerhaave* himſelf, had it not been for his laboratory, probably would never have known more of the contents of the atmoſphere than *Agricola!*—nor *Van Helmont* been more certain that ſoil was not the food of plants than his predeceſſors, had he not ſatisfied himſelf by experiments!* But let us proceed—The reſult of various experiments, *Agricola*, carefully made by gentlemen of veracity, demonſtrate that the atmoſphere is replete with AIR, WATER, SALT, EARTH, OIL, and FIRE:† and the decompoſition of bodies clearly announce that thoſe elements (portioned, and blended at the election of the different fami-

fami-

* THAT gentleman was the firſt that proved the ſoil was not the food of plants, by planting a cutting of willow that weighed 5 lb. in an earthen veſſel which contained 200 lb. of ſoil, and ſpace to hold water, which it was ſupplied with as often as needful, and great care taken that no freſh ſoil was added. At the end of five years the tree which the cutting produced weighed 169 lb. odd:—the ſoil was then taken out of the veſſel, and brought to the degree of dryneſs it was when put into the veſſel, and ſtill weighed its firſt weight, abating two ounces. After him Mr *Boyle* proved the fact on other ſubſtances; as have divers other naturaliſts at home and abroad.

† THE ſalt, earth, oil, and fire here meant, are diſtinguiſhed by chymiſts as follows, *viz.* Nitrous ſalt, elementary earth, eſſential oil, and elementary fire.

families or orders in the univerſe) are all the materials the adorable Author of Nature has condeſcended to employ in the ſtupendous works of creation. And the illuſtrious Sir *Iſaac Newton* has ſhewn that thoſe conſiſt of atoms or particles which are immutable:—"They are (ſays he) ſo hard, and indiviſibly ſmall, that they cannot be broke to pieces by human force; nor can they ſuffer any diminution by wear:—Hence they may compoſe bodies in all ages by new aſſociations." And as the atmoſphere is an aſſemblage of thoſe primary atoms or particles which have conſtituted bodies of various denominations, and have been thrown out of the ſpheres of their reſpective attractions by fermentation, or ſome other mode of diſſolution; they deſcend on the earth, and aſcend to the regions of the atmoſphere alternately, until they are retained by the former, in order to engage them in new aſſociations.

HERE again, *Agricola*, the wiſdom and juſtice of the adorable Author of Nature appear exceedingly conſpicuous, in as much as he hath limited the excurſions of thoſe fugitive or forlorn atoms to our own atmoſphere;* and giving it ſuch motion as communicates them in due ſeaſon to every quarter that is prepared for their reception.

ALMIGHTY GOD having thought proper to make every thing out of thoſe primary atoms or elements, and to make them ſo hard, and indiviſibly ſmall, that they can neither be divided nor annihilated by finite power: and likewiſe limited ſuch of them as are evaporated, to the regions of the atmoſphere;

* BY the law of refraction it is manifeſt that nothing leſs ſubtile than light itſelf is to be met with at more than forty-five miles from the ſurface of the earth.

ſphere: and moreover given every ſpecies or family HE has created, inclination and ability to enliſt and aſſimilate thoſe primary atoms or elements into their own nature, when they ſhall fall within their reſpective ſpheres; and appointed an infallible means* for the purpoſe of conducting them to the great emporium or receptacle of their ſupport.† We muſt therefore, *Agricola*, with reverence, preſume the whole manœuvre of ſucceſſion and duration, reſpecting vegetable and animal exiſtence, to be open to our view, and are comprehended in the few following particulars: viz. *Perfect organization, proper ſituation, and a convenient ſupply of thoſe primary atoms or elements.*

HENCE it alſo follows, that as the adorable Creator at once furniſhed the world with a full meaſure of materials, which cannot be annihilated by finite power, that it muſt endure for ever; and maintain an endleſs ſucceſſion of temporary ſyſtems, unleſs it is the will of the Creator to devote a change.

I HAVE yielded to this digreſſion, *Agricola*, on purpoſe to furniſh thoſe who think this earth or planet we inhabit, has ſuffered, or is capable of ſuffering, any diminution by time, with a ſimple and ſelf-evident proof of the contrary. But at the ſame time wiſh they and all others would be pleaſed to advert, that there is a poſſibility of a partial accumulation of the

* *Viz.* So adjuſted the atmoſphere, that when its predominant element (air) is ſaturated with the predominant element of the earth (water), it quits its hold:—hence the primary atoms in the atmoſphere are brought back to the earth in rain or in ſnow, hail, dew, &c. according to the ſtate of heat in the atmoſphere.

† THE ſoil.

the antiquated particles. For inſtance, every particle or atom which has been employed in the fabrication of (land) animals and vegetables, &c. thrown into the ſea either by rivers or the atmoſphere, &c. gives the balance againſt terra firma.* Ought we not therefore to be exceeding careful to prevent ſuch emigration, if we wiſh the land to keep its place and fruitfulneſs? We ought alſo to be exceeding careful to prevent all manner of diſſolution of bodies in the walk of the atmoſphere; as it not only robs us of the primary particles or atoms which theſe bodies contained; but when it is in a moiſt ſtate, and becomes replete with them, is unwholſome to breathe in, and conſequently ſubjects us to the hazard of various contagious diſeaſes.

Agric. I PERCEIVE by this, Sir, you condemn the practice of thoſe who expoſe ſmall heaps of dung to the open air.

Phil. THAT I do, *Agricola*; they evidently, in ſo doing, give the air the faireſt chance to deprive them of every particle that is diſengaged. It is waſteful even to place a dunghill where the air has a great current; but when huſbandmen plant their fields with ſmall heaps of dung, and ſuffer them to remain either in that ſtate, or ſpread without cover, it is evident from the above principles, and alſo confirmed by experience, that the loſs is very conſiderable. For as there is no other food or means of ſubſiſtence for a crop, but antiquated particles, which are either in the ſoil or brought to it, there can

* IT cannot be ſuppoſed, but that the adorable Creator of the world foreſaw that ſuch emigration of particles would obtain; and has deigned to adjuſt or repleniſh them, probably by regular ſucceſſion: *i. e.* as much as the ſoil, &c. which cometh from land occupies of the ſea, ſo much ſhall ſhe intrude herſelf into land.

be no management more prepoſterous, than that of beſtowing them on the atmoſphere ſo wantonly. It ought, on the contrary, to be the object of the huſbandman's utmoſt care, to diſengage and retain them for the ſuccour of his crops. And the moſt effectual way, that I know of, to anſwer that end, is to chooſe a low, but dry ſituation, for dunghills, and to turn them in calm moiſt weather; and finally, when they are in order to be carried upon the land,† that the heaps be ſpread immediately, and plowed down without loſs of time; and a moderate dreſſing of quick lime ſpread upon the ridges as ſoon after as may be.

Agric. I DOUBT not but ſuch treatment will make improvement, Sir; but I preſume it ſtands to an high expence. We think ourſelves happy, when we can procure as much of one ſort of manure as will dreſs our lands;—how it may ſuit to furniſh two kinds, I am at a loſs to ſay.

Phil. THE additional expence of a moderate liming upon the field which has been alſo dreſſed with dung, in places where lime is manufactured, will be very inconſiderable; not more, I dare ſay, than 2*s.* 6*d.* an acre:—and in places where they have no lime, there are other abſorbents which may be uſed with perhaps equal ſucceſs: *viz.* chalk, wood-aſhes, fern-aſhes, *American* pot-aſhes in ſmall quantities, ſoaper's refuſe, *&c. &c.* each of which has a tendency to effect the ſame purpoſe;

† THE condition of dung to anſwer the beſt purpoſes, depends upon the quality of the ſoil in a great meaſure; for a cold clay will receive greater advantage from a dreſſing of half-rotten ſtable dung, than from a dreſſing of black dung of the ſame quantity; becauſe the fermentation which the former occaſions, animates the latent primary particles that are, as it were, frozen in the clay, as well as adds to them what itſelf contained, &c.

poſe; and therefore that which is moſt convenient may be uſed.——You have ſeen, *Agricola*, that the atmoſphere has been appointed by the wiſe Creator to collect ſuch atoms as are diſſipated and ſent abroad from the earth; whence as fermentation and ſolar heat are capable of diſperſing them, whenever we raiſe a fermentation in our land, or expoſe it to any conſiderable degree of heat,* we moſt certainly ſhould cauſe ſome body to interfere, whoſe province it is to retain ſuch particles as would otherwiſe be carried off by the atmoſphere. I mean to preſerve the greateſt diſtance from any attempt to deceive, *Agricola*, and therefore cannot flatter; yet I will venture to aſſert, that manure huſbanded as above, will have at leaſt one-third greater effect and duration, than if left to be embezzled by the atmoſphere.

Agric. I HAVE always thought that a too free expoſure was hurtful to dung; but never until now looked upon it as one-tenth ſo ſerious a matter as you have made it appear to be.—And I alſo apprehend, that when we top-dreſs our meadows, &c. with dung, we ſuffer greatly by the atmoſphere at all ſeaſons.

Phil. THAT is a theory which none ought to diſpute, *Agricola*; for every body knows that winds, &c. take off water; and the experiments of *Van Helmont*, Mr *Boyle*, *Bonnet*, *Duhamel*, *Triewald*, and many others, prove beyond a doubt that vegetables can derive all their conſtituent parts from water, even their ſalts and oils, as well as their earthy particles, &c.——

* ACCORDING to Dr *Hales*'s experiment, any degree of heat beyond the 40th of *Farenheit*'s thermometer, diſſipates the moſt viſcid and glutinous of them.

Hence it is evident that water is a proper vehicle and *involucrum* to every other ſpecies of atom.

LIME, beſides being a very powerful abſorbent, is peculiarly ſerviceable to the huſbandman when properly handled; in as much as it attenuates the oils contained in animal and vegetable manures, and renders them miſcible with water, without which they cannot enter the pores of the radical veſſels of plants. It alſo, by its ſuperior ſpecific gravity, when ſpread on the ſurface of the land, approaches nearer to the roots of the plants, as its virtues abate; which gives the radical veſſels full opportunity to extract every particle that had not been communicated to them by filtration: and when become effete, mingles with the under ſtratum; and even then is of benefit, in as much as it renders it leſs porous, if a ſand;—and if a clay, ſhould there be any virtue at all left in the lime, it will proportionably enliven it. Upon the whole, *Agricola*, lime in ſmall quantity having ſo many good effects on every ſoil, except thoſe of its own nature; and no other inconveniency than its coſt, which (unleſs in particular places) is ſo inconſiderable, that it cannot be pleaded in bar; I ſincerely wiſh huſbandmen for their own benefit, and that of the public, would dreſs their plowed land with it, at leaſt every other year, at a ſeaſon conſiſtent with its properties.*

Agric.

* IT is impoſſible to mention the preciſe quantity, becauſe that depends in a great meaſure on the quantity of acids the ſoil contains; much acid requiring a larger quantity of lime than is otherwiſe neceſſary, &c. Beſides, there is a wide difference in the ſtrength of lime:—in the ſouthern parts of the county of *Durham*, there is a lime made from a white ſtone, at leaſt double the ſtrength of the lime made of the blue lime-ſtone, or *Devonſhire* marble. It is alſo neceſſary to be obſerved, that a large quantity of lime, inſtead of attenuating the oils and juices capable of becoming the food of vegetables, will coagulate them: great care ought therefore

Agric. SIR, I begin now to ſuſpect that I have hitherto conſidered lime in a very improper point of view; having always reckoned it a manure.

Phil. I REMEMBER you did call it a manure, *Agricola*; but I did not reply to it, for people often expreſs their ideas according to appearances; even the incomparable *Newton* could be guilty of that; for it was remarked he would ſay, "the ſun riſes and ſets;" that being moſt agreeable to appearance, altho' he well knew the contrary.

Agric. THAT, Sir, is an apology exceedingly more liberal than I am deſerving of; for I did not expreſs it on any other account than want of knowing the contrary.

Phil. As I am ſenſible, *Agricola*, that you would rather devote your time to receive inſtruction than compliment; I reſt ſatisfied you will excuſe my deferring the reply your ingenuous confeſſion ſo highly merits; and for the future attend to the following arrangement of manures, *viz.* into eſſential and inſtrumental, as the true criterion of diſtinction; for the common acceptation of the verb is ſo exceedingly vague, that every operation of the huſbandman falls under the denomination of manure.

HENCE

to be taken to avoid ſo deſtructive a meaſure; and rather to err on the ſide of a minor than a major quantity, for thoſe *tertian* dreſſings, which may be ſafely fixed at twenty *Wincheſter* buſhels in flour of the ſtrong lime *per* acre, when the ſoil is freſh, and a little leſs when old, &c. or forty ditto, in the ſame ſtate, of the lime made from the *Devonſhire* marble, or other light-blue lime-ſtone, and a third more of chalk, &c.

HENCE, according to the above diſtinction, lime is only an inſtrumental manure; its uſe being chiefly to attract and attenuate the juices which contain thoſe active atoms or eſſential materials:—wood-aſhes, fern ditto, and all other kinds of aſhes, fall under the ſame denomination:—and all manner of animal and vegetable ſubſtances afford the eſſential manures, or real, primitive, active, nutritive particles; they being the ſtructures the wiſe Creator has appointed to be erected out of them; and the atmoſphere and ſoil are appointed as magazines or repoſitories of them when out of employ, if I may ſo ſpeak.

HENCE the whole buſineſs of huſbandry is to be comprehended in the few following ſimple conditions, *viz.* Firſt, That as a ſucceſſion of animals and vegetables are kept up by a rotation of primary indiſſoluble atoms; and a reproductive capacity implanted in the inhabitants of thoſe kingdoms. And as thoſe atoms are confined to the atmoſphere, the ſoil and waters, when unemployed; and as the ſoil is the univerſal baſis or ſtomach, as we have alſo called it, of vegetative life, we ought to preſerve its proper tone and aptitude for receiving and retaining thoſe primary nutritive atoms. And ſecondly, As the aſſimilation of the primitive particles, and conſequently the growth and increaſe of vegetables and animals depend upon their peculiar organization and ſtamina, that thoſe ſhould be attended to and preſerved with the utmoſt aſſiduity and care. How the ſoil is to be treated, in order to perform its office, has been in ſome meaſure explained; however, before we proceed to the other particulars, *viz.* the due care of the organization and ſtamina of plants and animals, we will take a ſummary view of what has been advanced relative

tive to the condition of the ſoil, the atmoſphere, and inſtrumental manures.

AND firſt, then, we have obſerved, that to accommodate the radical veſſels or roots of plants, it is neceſſary to pulveriſe the ſoil to a proper depth; hence the uſe of plowing, harrowing, &c.——Secondly, In order that the crop or plants receive the greateſt advantage, there ſhould only be ſuch a number raiſed, as the condition of the ſoil, &c. can fully ſupply; hence the uſe of a regular and determined method of depoſiting ſeeds. —Thirdly, That every aſſiſtance ought to be adminiſtered to eſchew the ſeverity and inclemency of ſeaſons, &c. hence the uſe of draining, water-furrowing, ſheltering, &c.—Fourthly, The accumulating and retaining of primitive atoms; hence the uſe of mixing with the ſoil, dung, and other animal and vegetable ſubſtances, and ſtrewing the ſurface with abſorbents, attenuants, &c. *viz.* lime, chalk, wood-aſhes, fern-ditto, or any other kinds of vegetable aſhes, marles of every denomination, virgin ſoils,* &c. all of which we claſs as inſtrumental manures..

Agric.

* LIME-STONE and chalk, even while raw, attract the oleaginous particles of the ſoil and atmoſphere very powerfully:—(in the former, it is very conſpicuous before rain; for as the atmoſphere then abounds with watery particles, and the ſtone rather repels than attracts that element, the weeping or oozing which appears on the ſurface of the ſtone before rain is thereby occaſioned; hence they may be depended upon as hygrometers):—Therefore I am of opinion that lime-ſtone is endowed with ſuch a vigorous ſtamina, as even after it is broke off from its ſepta to vegetate, unleſs expoſed to a degree of heat that diſſipates the nutritive particles. This opinion is corroborated by its peculiar duration. Nor is this extraordinary vegetating quality annihilated by calcination; for fine lamellæ or plates of limeſtone are generated on the ſurface of a veſſel of lime-water, that has been at reſt ſome time. Upon this principle, every effect of lime is to be eſtimated as follows, viz. as it at-

Agric. HAVE virgin ſoils that property, Sir?

Phil. YES, *Agricola*, all ſoils have that property more or leſs, until they become defunct by indiſcrete management, &c. and even then, when ſuffered to revert to a ſtate of nature, in a convenient ſpace of time they recover it, as experience doth abundantly teſtify.†

Agric. HENCE I infer that all ſoils are more or leſs poſſeſſed of a marley quality.

Phil. THAT is a very fair inference, *Agricola*; ſoils certainly, whatever difference there may be in their complexion, texture, ſpecific gravity, &c. as they are all poſſeſſed of an attracting quality, do very properly fall under the denomination of marle; that quality being its peculiar and natural property. There is

tracts the nutritive particles for its ſubſiſtence, we can no more be benefitted by them, until it is effete, than we can by the particles any animal or vegetable ſubſtance contains, until they are in a ſtate of diſſolution.

LET us therefore attend to thoſe means which render it effete; and this, experiment evinces to be moſt effectually performed by ſaturation, or an exceſs of nutritive particles.—The attraction then becomes ſo languid, that the ſoil ſupplants it, as gravity does the attraction of the magnet when it has above its full load:——which ſhews that in old weak ſoils, the quantity of lime muſt be very moderate, otherwiſe it will be an over-match for the ſoil; of which there needs no other proof, than the fate of ſoil on which lime heaps have been laid. It is alſo to be obſerved, that whatever obtains in lime, will likewiſe with chalk and marles, whether raw or calcined, they being ſimilar in their natures, as Count *Gyllenburgh* and Dr *Home*'s experiments clearly prove. They are not, however, equally ſtrong; and therefore their quantities, to have an equal effect, muſt be proportioned thereby. Calcined vegetables alſo act in a manner ſimilar to the above, and are more or leſs powerful, according to the ſtrength of the radical ſtamina:—hence it is that fern, and moſt of the *cryptogamia* claſs which generate fromthe root, become the ſtrongeſt abſorbents or alkalies.

† HENCE the uſe of fallowing, and changing corn-land to paſture, &c.

is no doubt a wide difference in the degrees of attraction they ſeverally poſſeſs, in different provinces and ſituations; but whether that is altogether accidental, or otherwiſe, I pretend not to determine. However, as the uſe of the ſoil, in the vegetable world, is chiefly to attract, attenuate, and retain the elements which come into its neighbourhood, either by fortuitous means or the hands of man;—it follows, that whatever ſoil is moſt poſſeſſed of theſe qualities, may be put up as the true criterion or ſquare to judge from, reſpecting good and bad ſoil.

HERE, again, our theory recurs to the analogy between ſoil and the animal ſtomach; the higheſt perfection of which is well known to be real appetite and true digeſtion; and theſe depend on a nice adjuſtment of its parts; viz. their being neither too large, nor too ſmall; too frequently, nor too ſeldomly uſed; too much braced, nor too much relaxed; too dry, nor too moiſt; too hot, nor too cold, &c. but in a due medium with reſpect to them all; and juſt ſo it is with the ſoil, when it produces the beſt crop poſſible, *cæteris paribus*.

Agric. I THANK you, Sir, for this comprehenſive data; I entertain the utmoſt confidence that it is ſufficient to pilot any perſon of tolerable capacity through the wide extended province of agriculture.

Phil. IT will afford me great pleaſure, *Agricola*, to find your confidence reſts upon a ſure baſis; and as ſoon as I have diſcuſſed that part of our theory which relates to the due care of the organization and ſtamina of plants and animals, I ſhall do myſelf the ſatisfaction to proſecute a particular examination of your manner and ſkill, to apply it to a general practice.

Agric. I SINCERELY wiſh you may have an opportunity to favour me with ſuch a reviſe, Sir; and, in the mean time, I ſhall be careful to make preparation.

Phil. IF the tranſcript of what has been delivered in our converſations, can be of any ſervice to you, *Agricola*, you have my hearty welcome to carry them with you; and as I am to be from home a few days, they will at leaſt, if peruſed, keep your attention in a proper trim for a few more lectures on agriculture at my return.

Agric. YOU load me with obligations, Sir; the copy will, no doubt, be ſerviceable to me; I accept it with gratitude, and wiſh you every deſireable ſucceſs on your journey.—Adieu,

CONVERSATION IX.

PHILOSOPHUS.

I AM glad to ſee you, *Agricola*;—I thank you for your kind enquiry on my arrival, and hope I meet you well.

Agric. YES, very well, Sir; and am come to deſire you will favour me as uſual, if no way inconvenient.

Phil. IT is altogether convenient, *Agricola*; and by turning to a minute made at the cloſe of the diſcourſe, I find we were to enter upon that part of our theory which relates to the organization and ſtamina of plants and animals.

YOU will therefore recollect, *Agricola*, that we have hitherto, and indeed ever muſt conſider animal and vegetable *re-production* as a competent ſubſtitute (appointed by the adorable Author of Nature) for creation. How many more wiſe purpoſes thoſe two natures were deſigned to anſwer, I neither pretend to know, nor think it incumbent on me to ſay:—but the deſire of every individual to propagate and to preſerve their offſpring, (eſpecially the animal) evidently is ſuperlative to every other conſideration with them, even life itſelf. You need only ſuffer a few of the numerous inſtances your profeſſion furniſhes, to paſs in view before you, *Agricola*, to receive full conviction in this matter. The fate of *Arborator*, who was gored to death in attempting to carry off the calf of one of the wild cows in the park, (notwithſtanding a vigorous reſiſtance) is, though a

melancholy inſtance, a convincing proof of the predominance of the above law in that ſpecies of animals, while in a ſtate of nature:—for at all other ſeaſons they are ſo timid, that they fly at the ſight of a man; but at that they advance with menaces, and every mark of a fixed reſolution to protect their offſpring at all events.

THE park alſo affords another ſtriking inſtance of the peculiar prevalence of that law, *viz.* the ſagacity and fortitude of the hind, who generouſly preſents herſelf to the hounds, when ſhe hears them near her lodge, in order to divert them from her fawn!——The ewe, which of all other animals is the moſt fearful and irreſolute on common occurrences, will reſent an attack upon her lamb with indefatigable reſolution, deſpiſing wounds and even death upon the occaſion. Nor would the leaſt of our domeſtic animals ſuffer us to rob them of their young with impunity, were it not that our former kindneſſes render us unſuſpected.

THE ſame peculiar attachment to the offſpring is obſervable in the feathered tribe, which obtains amongſt quadrupedes:—for inſtance, the hen, which never retorts upon any other ſpecies but her own, except when ſhe hath young; and then no creature whatever is exempt from her reſentment, if they diſturb her chicks. Others of the feathered tribe, which have not weapons to fight with, are furniſhed with a ſubtility which ſtands them in as good ſtead:—thus the partridge, when a perſon comes upon her, before her brood are fledged, feigns herſelf diſabled of both leg and wing, frequently tumbling down, and hopping off in a very ſlow pace, or attempting to fly with one wing, until ſhe has enticed the perſon to leave

leave the young in expectation of catching her: thus by her artful and affectionate conduct, ſhe gains time for her young to hide themſelves; and ſoftens the moſt rigid ſolicitude for prey into contemplation.* And if the preſervation of the young is the chief care of the female of every denomination, it is no leſs the diſpoſition of the males, when neceſſary; and in every inſtance the latter bids defiance to danger, when the female intimates her deſire to propagate.——Hence it is that lions, bears, &c. combat one another upon theſe occaſions. But there is no occaſion to fetch examples from abroad; the diſpoſition of our bulls, ſtone-horſes, boars, rams, &c. when rivalled, afford ſufficient teſtimony of that aſſeveration.

AND when we attend to the efforts of vegetables to fecundate their ſeeds, we can have no doubt of reproduction being alſo the predominant law with them; becauſe as ſoon as they have completed it, they immediately fade away. This is evidently the caſe with annuals; and thoſe which are of the longeſt duration, as ſoon as they are incapable of producing ſeeds, do not long ſurvive that period.——We may alſo from their exertions to reinſtate the farina fecundans, when it happens to be defeated by accident, (which exertions often reduce them to the very article of diſſolution)‡ with the utmoſt propriety conclude, that propagation is the firſt or predominant law of nature in vegetables as well as animals. The

ſtretch

* AND then none but fools or children will be guilty of ſuch barbarity and waſte, as to take them in that immature ſtate, if they could even find them.

‡ WHOEVER pleaſes to attend to this phænomenon in wheat, will be ſatisfied that when the farina or bloom (as it is commonly called) is often torn off by winds, rains, &c. the corn is lean, and that the blooming ſeaſon is much the longeſt under ſuch predicament.

ſtretch which Nature is ſometimes put to, in order to make ſure of reproduction, alſo affords teſtimony that it is her ſpecial buſineſs.† Many other inſtances, ſuch as the ſeaſons and periods of geſtation, &c. might be collected in aid of this opinion; but it is certainly unneceſſary to dwell any longer upon the explanation of a matter ſo ſelf-evident. If then the adorable Author of Nature has been pleaſed to furniſh every ſpecies of animals, vegetables, &c. with ability to reproduce, by which means a chain of beings are preſerved independent of new creation, and HIS omnipotence clearly manifeſted:

WE cannot doubt of every object at firſt being altogether complete in the point of organization, inſtinct, &c.—hence the method Nature has adopted to prefer her breeders, commands attention; and firſt that which obtains amongſt animals.

LET us then ſuppoſe (which, by the bye, I believe will be more convenient in this age than trying the experiment) ten mares, and as many ſtone-horſes, of different ages, all grazing in one field, and no other weapons (ſhoes) upon them than Nature furniſhes them with:—when any one of the mares takes ſeaſon, I believe none will diſpute but it will be he which has

† THE *Valiſnieria* of *Linnæus* is an inſtance of what I preſume to call putting Nature to a ſtretch. That plant grows in rivulets, and both male and female ſpring from the ſame root, and thrive beſt underneath the water; but when they blow, their flowers muſt either reach to the top of the water, or they cannot expand.—To enable them to do this, and that the male flower may fall on the female flower, Nature is under the neceſſity of cauſing the female ſtalk to take the down water ſide, and always has a ſmall ſpiral ſtalk, by which means it reaches the ſurface of the water when it is ſtrongeſt, the ſpiral being then moſt extended. The male ſtalk is ſhort, and doth not reach the top of the water; but the flowers are thrown off from it, come up unopened, and then expand themſelves, and are carried by the current of the water to the female flowers which are at the ſame time blown, and are thereby impregnated.

has the beſt health and abilities, which will do the office. We know there will be a combat, and therefore it muſt be ſo decided, unleſs in caſe of accidents.* What obtains with that ſpecies of animals in this reſpect, has not an exception where Nature is left to herſelf:—and we may reaſonably enough conclude from hence, that it is on that account male animals are furniſhed with greater powers of propagation than the females, as their numbers are about equal.

Agric. I AM convinced, Sir, that is the method Nature in the animal kingdom adopts to chuſe her breeders; nor do I ſee it poſſible that any better method can be; for the ſucceſs is made to depend upon the health, reſolution, and ſtrength of body. Hence every blemiſh in courſe checks itſelf.—But I muſt ſtill crave your direction, Sir, how to apply it to our preſent mode of breeding.

Phil. YOUR remark, *Agricola*, is very juſt; for by the means Nature has appointed to determine who are to be the breeders, blemiſhes do certainly check themſelves; and with reſpect to my direction how to apply it to the preſent mode of breeding, you may freely command it.

IN the firſt place, then, the rearers of ſtock ought to attend to the ſtate of health, ſoundneſs, ſymmetry of the ſeveral parts, chearfulneſs, and viſible abilities,) as well as predominance in their diſpoſition for propagation) as the general marks or characteriſtics of proper breeders. There are, I own, many difficulties

* It is very obſervable, that when male animals fight on thoſe occaſions, they never attempt to wound the organs of generation; from which it ſeems as if the combat was not only inſtigated by Nature, but the manner of it preſcribed, &c.

culties to combat in adopting ſuch a choice:—for ſome ſtone-horſe maſters, bull-maſters, &c. are ſo abominably given to dictation, that before you can ever know the price of ſervice, you muſt ſuffer the mortification of hearing half an hour's rigmarole, by way of exordium, and afterwards as much more as you pleaſe. You will alſo meet with this ſort of manners and embarraſſment very frequently when you want to purchaſe ſtock; for ſure it is, and I am ſorry to find it ſo, that men now-a-days neither bluſh to ſing their own praiſe, nor to plague purchaſers with eulogiums on what themſelves have to ſell; and alſo to arraign their judgement, if they do not ſay *amen* to all their ſophiſtry.* But let not ſuch a deception obtain againſt you, *Agricola*; for notwithſtanding ſuch men, where their intereſt is not at ſtake, may be tolerable judges, yet when they are under its immediate influence, and every day availing themſelves of their art, there is hardly a poſſibility of their giving an impartial account, even when they mean it; for intereſt makes the tongue ſpeak all ſorts of language, and the judgement draw various concluſions.

IF, therefore, you mean to do yourſelf juſtice, *Agricola*, be careful to join a judicious theory to your practice in the choice of breeders, and alſo in the purchaſing of ſtock; whereby you

* IN ſome places this ſpecies of outrageous behaviour is become ſo faſhionable, that a man of good-breeding and delicacy finds himſelf under a neceſſity of apologizing to purchaſers for his ſilence as follows.—If you mean to buy thoſe goods, gentlemen, pleaſe to examine their condition, &c. and ſuch queſtions as you think proper to aſk me relative to them, I am willing to anſwer faithfully. But although it is become faſhionable for ſellers to ſay much in praiſe of their commodities, yet I think it an inexcuſeable piece of rudeneſs, and therefore hope you will judge for yourſelves, and think no worſe of my goods for ſuch deviation, &c.—By which he both pleaſes the purchaſer, and relieves himſelf.

you will be able to judge for yourſelf. Hence it will be neceſſary to be acquainted with the ſtructure and œconomy of the animal ſyſtem, at leaſt of ſuch as your ſtock conſiſts of, viz. the horſe, cow, ewe, and hog. To facilitate this, I will give you a few remarks a friend of mine obliged me with.

THE head of a horſe (ſays he) beſides its being the reſervoir of the brains, the ſeat of viſion, hearing, taſte, maſtication, &c. when in its beſt form, (and ſuch as Nature originally made it) is long and ſmall towards the extremity, and this for obvious reaſons, viz. that they may reach the ground with eaſe; that there may be ſufficient ſpace for maſticating the food without ſhifting it out of a direct line with the throat; and in order to furniſh the lungs at all times with plenty of air, and the ſenſe of ſmelling complete, the noſtrils ſhould be wide.—The eyes ſhould be lively and prominent, in order to command the greateſt field of view:—the forehead large,—and the ears, long, ſmall, and upright; becauſe his province being to travel, he carries them eaſieſt in that poſition, and they alſo, in that poſition, coincide more with the aperture of the internal ear:—the neck long, and of ſuch a curve as will beſt receive, convey, and deliver the food and breath of the animal, but withal both head and neck as meagre as poſſible; for much fleſh on thoſe parts only ſerves to fatigue the creature, and make him unſightly. If the horſe is intended for the ſaddle, or to beget ſuch, the fore thighs ought to ſtand ſtraight and upright; the breaſt narrow and deep; conſequently the ſhoulder broad, deep, and thin at top · the legs in a line with the thighs, and the paſterns ſhort and upright; the hoof circular, and the heel wide; and the leg, when folded back, ought to be in a line with the thigh, otherwiſe there will be an unjuſt deal:—the paſtern and knee joints clean, but full in

ſize; for if the ends of a leg or thigh bone are ſmall, there is a great probability of the bone being weak. Beſides, as thoſe joints are deſigned both to ſuſtain and move under the creatures weight and load, by being ſmall, they ſink into one another ſo intenſely, that the ſecretions intended to lubricate the joint, is preſſed out on all ſides, and ſoon form excreſcences which render the creature not only numb and inactive in thoſe parts, but egregiouſly unſightly.

WHETHER my friend is quite orthodox, *Agricola*, in regard to the lubricating or oily matter being thruſt out for want of a proper baſis, and by too heavy a load on it, and thence forms excreſcences, &c. I do not pretend to determine; but it is truly conſiſtent with the nature of things, that if the ſocket and ball of a joint are ſmall, the contact will be more intimate *(cæteris paribus)* than if large, and conſequently occaſion greater wear upon the cartilages of the joints, elſe why do narrow wheels ſink deeper in roads than broad ones; or the head of a cane prove eaſier for the hand than the pike in its other end, &c. It therefore ſeems highly proper to chuſe a horſe well proportioned in his joints, and with a ſtrong bone.* The ſtrength of the thigh is next to be attended to; the ſureſt indica-

* THE ſtrength of bones does not conſiſt in the dimenſions, but the texture and fineneſs of the lamellæ or plates they are made up of;—the ſmall bone may therefore be ſtronger than the large one; but as there is no way of judging preciſely of the texture or fineneſs of the lamellæ, while the creature is alive, it is worth while however to attend to ſuch circumſtances as are moſt frequently the concomitants of fine lamellæ in the leg and thigh bones, viz. a large ball and ſocket, and clean ſtrong ſinews or muſcles; for Nature, unleſs by accident, never botches her work: hence we may depend upon it, that if the leg-bone has a good head, &c. and the muſcles fine and ſtrong, and withal well inſerted, (of which the largeneſs of the end of the bone is a proof) that although the leg be ſmall, it will be ſufficiently ſtrong, and its leſs weight is a great advantage.

indication of which is a perfectly gradual increaſe of its dimenſions from the knee to the elbow, or ply under the ſhoulder, and the fore gaſcoine or chamber where the bellies of the muſcles ſwell, (if there is no inflammation) ought to be protuberant, full, and fibrous. The back ſhort and broad over the kidneys, and gently riſing from the end of the chine (which ought itſelf to be a little convex) to the top of the ſhoulder. The ribs broad, and the trunk or cheſt of the creature cylindrical. The belly ſtraight, but rather tapering ſomewhat towards the hind thighs; and the muſcular braces which extend from the hook to the lower belly, over the flank, ſtrong and properly directed:—and in order to give thoſe braces the beſt direction, both with reſpect to the breathing of the creature, and ſuſpending the belly moſt effectually, the hooks (at the place of inſertion of thoſe muſcles) ought to be wide; otherwiſe the belly will ſink, and the ribs become flat.

THE roof of the hind thighs ſhould approximate to a circle longitudinally; becauſe in that figure the extenſers or muſcular braces have the greateſt effect, *cæteris paribus*; and the horſe has alſo a much better appearance. And as the hind quarters of a horſe are fixed to his body by articulations or joints, and not merely by appoſition and muſcular faſtenings, as his fore-quarters are, the wider he goes, (unleſs it amount to an extreme) the better; becauſe the motion of the thighs will thereby leſs diſturb his breathing; neither will they be impeded by his flanks. The hind thighs ought, as well as the fore thighs, to be ſtrong, and the gaſcoines full and muſcular: and what has been mentioned as neceſſary to the fore-legs, paſtern, &c. ought alſo to obtain with reſpect to the hind-legs, &c.

A HORSE choſen according to thoſe out-lines, and withal poſſeſſed of health, ſize, proportion, ſpirit, and docility, bids fair to anſwer the ſaddle, or beget ſuch as will anſwer it, in a ſuperior manner; provided he is properly ſuited with mares, and not out-done by an improper number in a ſeaſon. And to form an adequate idea of what that proper number is, breeders had better attend to the proceſs of ſecreting the ſemen from the blood and humours of the animal, than the preternatural romance of horſe-keepers:—as by the former, they may be convinced that two mares in the week are more ſuitable to the true intention of propagation, than two in a day; although ſome do not ſcruple to give ſervice (ſuch as it is) to two in one hour. From ſuch abuſes, and the little attention given to the faſhion of the mares, we may venture to aſſert, proceeds the degeneracy of ſpirit, the ſize, and the mutilated ſhape of our horſes.

WHAT has been remarked with reſpect to the form of a ſaddle horſe, and alſo with reſpect to ſervice of propagation, holds good in every other appointment of horſes, with the following variation, *viz.* ſuch as are for the plough, waggon, and cart, will anſwer thoſe purpoſes, although they have broad breaſts, thickiſh ſhoulders, and the legs heavy; but even in ſuch, theſe deviations ought not to be carried to an extreme.

I SHALL, in the next place, *Agricola*, recite my friend's remarks on the cow kind; and firſt of the Bull.

THIS animal, as he feeds in a horizontal poſition, like the horſe, muſt find great convenience in having the head long, and ſmall towards the muzzle; his eyes ſhould alſo be large

large and protuberant, black and rolling; his forehead broad, and cloſe ſet with ſhort curled hair; his ears long, hairy within and without; his horns (whatever kind he may be of) longiſh, clean and bright.——And as Nature has deſigned his head as his principal inſtrument both of offence and defence, it ought to have every mark of ſtrength, and alſo be proportionably aided by the neck; hence it is that the necks of thoſe creatures are of ſuch an enormous ſize:—and as it has been ſo directed by Nature, we may reſt ſatisfied it is altogether proper. The large muſcular neck therefore, provided it be well proportioned in its parts, and the head finely connected therewith, of all others deſerves preference.—It ought not, however, to be incumbered with a coarſe wreathy ſkin and dewlap;—the latter, on the contrary, ought to be thin and ſupple; and the former tight and ſmooth. The breaſt ought to be large, and the ſhoulders deep, thick, broad and high; the back ſtrait and broad; the ribs broad and circular; the belly deep, ſtrait, and tapering a little to the hind thighs, which ſhould be large and ſquare. The roof ought to be wide, particularly over the chine and hooks; and the tail (if the bull is of the true *Engliſh* breed) ſhould not extend far up the roof; and ſhould be ſtrong and deep, with much lank hair upon the under part of it; and the hind part of the buttock rather ſquare than exuberant; from which mark there is an abſolute certainty he does not partake of the buffalo or muſcular thighed breed, which are the worſt feeders; and alſo the worſt proof for the butcher of any this nation at preſent bears. The joints and legs ſhould be ſhort and ſtrong; and the body long, deep, and round, filling well up to the ſhoulder and into the groin.

As

As for the viſible organs of generation, as I have formerly hinted, in every inſtance let them be not only without blemiſh, but in every other reſpect unexceptionable; and the diſpoſition of the creature eager to employ them:—and it ſhould be the maſter's care to guard againſt every means which tends to defeat ſuch vigour; becauſe although moderate exerciſe in that way increaſes deſire, it is no leſs certain that exceſs not only abates it, but renders the offspring deficient in ſize, ſpirit, health, and faſhion. He does not pretend to appoint the real number which the bull can, without injury to himſelf and the breed, give ſervice to:—that, he ſays, is well known to depend upon the age, health, and keep of the creature, and diſcretion of the people that attend the ſervice, &c.—For if the bull is ſuffered to leap more than twice (and that he will do in a few minutes) in one day, he probably either receives or does an injury; and adds, that thoſe days ſhould not come too frequent.

WHILE we are upon this ſubject, I ſhall, (as they are by far too intereſting to be loſt) recite ſome further remarks that he has made on the organs of generation; notwithſtanding in licentious times they ſhould meet with animadverſion.——And FIRST,

HE conſiders every ſpecies of animals as divided into ſeveral races, greatly differing in ſize, as well as in other particulars; and concludes, as Nature does nothing in vain or improper, that the genital organs were proportioned to the ſizes reſpectively; and moreover, as thoſe organs are not affected by the labour of the creature, but principally appertain to the work of propa-

propagation, that they are, of all other parts of the body, the leaſt liable to innovation, and deviate the leaſt from their originals:—whence breeders, ſays he, may ſhrewdly gueſs whether the creature (eſpecially the male) is capable of improving in point of ſize, or in hazard of falling back. For where creatures of the ſame ſpecies are nearly of a ſize, *cæteris paribus*, and yet a vaſt diſproportion in the organs of generation, it is evident that they are of different races, and thoſe that are minor in thoſe organs, are the offſpring of a ſmall race, which have had their bodies increaſed beyond the natural ſize by eaſe and pampering; and conſequently will dwindle off again to an inferior ſize. Whereas thoſe who have the organs of generation major, notwithſtanding their bodies, are ſeemingly out of proportion, are the deſcendants of a large race, and conſequently will increaſe in ſize, if properly ſupported. He has, he ſays, attended ſtrictly to this idea many years, and has not met with an exception to its indications.—The thought is plauſible, I own; and indeed no way unnatural; and as ſuch a choice can be attended with no inconvenience, *Agricola*, I leave the remark with you as freely as I had it.

My friend alſo ſtrongly recommends having the male and female both of a race; becauſe experience has made him certain that when a croſs is made, the offſpring is ſure to inherit the blemiſhes peculiar to each race; which inconvenience continually multiplies upon the ſucceeding generations. Whereas when the race is kept diſtinct, Nature directs her efforts againſt every blemiſh, and often turns out an offſpring greatly ſuperior to the parents.

AND with reſpect to the colour of the cow and horſe kind, he pronounces the black and dark red the beſt; and white, of all others, the worſt;* and grounds his aſſertion on the following rational theory, (to wit):—That the dark colours abſorb the rays of light, and thereby warm the ſkin in the cold ſeaſons, whence the pores are kept open, and the creature perſpires freely;—whereas the white reflects all or moſt of the rays of light; hence the ſkin, for want of heat, contracts ſo, that perſpiration is quite checked, and (if great care is not taken) many loathſome diſorders do enſue.

HE next deſcribes the Cow; and ſays, for the ſame reaſon that the head of a bull ought to be longiſh, and ſmall towards the muzzle, ſo ought the cow's; her forehead ought alſo to be broad; her eyes large, prominent, and lively; her ears longiſh, and (like the bull's) hairy within and without, and inclining to an erect poſition, and the horns clear and ſmall.—The neck long, thin, ſmall and clean; the breaſt full, and the ſhoulders broad, deep, and high; the back broad, and rather convex than ſtraight, but withal plain;—the ribs broad, wide between, and ſo diſpoſed as to form thoſe parts of the body they extend to into the ſhape of an hogſhead or kilderkin. The belly as ſtraight with the breaſt-bone as may be; her milk veins large, and her udder long, wide, and deep; but withal (unleſs diſtended with milk) it ought to handle ſoft; and at any rate be furniſhed with four large teats, planted pretty much apart. The hind thighs ſtrong, broad, and ſquare behind, and the houghs ſtraight:—the legs ſhort and

* THE cow kind may be pied a little without much inconvenience, as it is an ornament.

and clean, the knees fine, and the feet large and hollow, with firm, clear hoofs. The cow ought to be wide round her poſteriors, and long from thence to the hooks, which ought to be large, round, and wide. The roof ought to be broad, long, and concave, riſing gently to the coppelling or rump, which muſt be ſtrong, gently-waved, or indented, but withal ſnug;—the tail broad and long, with plenty of lank hair at bottom; and the width of the chine and length of the body of the cow, he ſays, never knew an extreme.

Agric. PERMIT me, Sir, to inform you that (from a practice of ſome extent) I give the dictator of thoſe remarks credit for their validity. It is the very parts he remarks that ſhould be large, *viz.* the roof, the chine, the thighs, and body of the cow-kind; as they not only fetch the beſt prices at market, but are the readieſt ſale: it is the ſurloins, rumps, runners, plates, flanks, buttocks, &c. that pay the butcher, and enable him to pay us. Nor will you, I hope, charge me with partiality to the remarker, when I aſſure you, that I have known near forty ſhillings difference in the amount of two carcaſes of equal weight and condition, merely on account of one weighing moſt in thoſe parts, and the other moſt in its neck, houghs, and other lumberous and low-priced ſpots.

NOR do the cattle he deſcribes require any better or deeper food, greater care, or leſs fatigue, than the random breed:—on the contrary, they excel in all thoſe perfections, and in every article I can recollect. In ſhort, I know not a ſet of men that have deſerved better of their country than thoſe who have ſtood forth to rectify the mould of our cattle, which had, by inattention, croſſing, &c. ſo very much degenerated.

Phil. YOUR experience in this matter, *Agricola*, gives me much ſatisfaction.—I hope I ſhall remember to announce it to our common friend.—He next, *Agricola*, deſcribes the ewe and ram as follows.-----Hark!—hey-day!—they warn us to ſupper. I proteſt I did not think it ten o'clock; but ſo it is, I dare ſay, for *Soror* is ever punctual.—We will therefore, at preſent, only mark the period, and proceed from thence next meeting.

X. CON-

CONVERSATION X.

PHILOSOPHUS.

AT the close of our last converſation, *Agricola*, I had juſt mentioned, that my friend next deſcribes the ram and ewe, and gives the criterions which diſtinguiſh the beſt ſhape of every race or breed as follows, *viz.*——The ram, ſays he, ought to have a large long body; his head (above and between the eyes) broad, round, and riſing; his eyes large and chearful; his noſe long and hooked; ſtraight, ſhort noſtrils, and thin muſcular lips. His teeth fair ſet, ſtrong and white; his gums red, and his breath ſweet; his under jaw wide, and free from glandular kernels; his ears long, and red within; his neck and head finely connected or joined, and the former very ſtrong; the ſhoulders and back nearly level, and both as broad as poſſible:—the ribs broad and circular; the body filling well in below and behind the ſhoulders, and ſwelling out at each ſide at middle, analogous to what has been ſaid on that part of the cow. The breaſt ſhould be broad, and as deep as to form a line with the belly; the forethigh round, plump and large; the knee joint ſhort and ſtrong; and the length of the leg ought to be in proportion to the other members of the body.* And, as in the horſe, &c. if the ſtrong, hard bone could be known by any means, it

* WHEN the legs of ſheep are ſo exceedingly ſhort as to let their bellies ſweep the graſs, &c. (and ſuch a breed has for ſome time paſt been much in vogue) there are ſeveral inconveniences attend it;—for inſtance, it ſhews the creature

ought to be preferred to all others, notwithſtanding it might ſeem ſmall for the carcaſe, as the creature and his deſcendents will be exceedingly more valuable at market, *cæteris paribus*, on that account;—for it is greatneſs of fleſh not of bone, which pleaſes the butcher and conſumer. Beſides it is a direct fact, that a ſmall hard bone is ſtronger than a large fungous bone; and therefore all the good purpoſes which the bones anſwer to the creature, may be anſwered by the hard ſtrong bone, though ſmall, and many inconveniences avoided. The only difficulty is to diſtinguiſh it while the creature is living; on which little more can be ſaid than has been diſcuſſed when deſcribing the leg-bone of a horſe. But it would be to me, ſays my friend, a matter of exceedingly greater ſatisfaction to review a ſample of dry bones really collected from the race or breed I was about to breed from, than to peruſe a volume of pedigrees relative thereto.§

THE hind thighs ought to be round, deep grown, and fill well into the groin; the roof or coppeling ſtrong, and the width of the chine and length of the body, (as was ſaid of the cow kind) provided the latter be ſtraight, cannot amount to an ex-

to diſadvantage, in as much as they have almoſt as much the appearance of huge mold-warts as ſheep. But this is one of the leaſt material objections;—for by the belly being continually kept wet, when there are either rains or dews, the wool is thereby injured, and the creature much ſubjected to bowel complaints. They are alſo much retarded in their retreat when danger approaches; and finally much worſe qualified to ſcan their paſture, to ſelect their food, &c. than when the legs are of a moderate length.

§ IT is worth a breeder's while ſometimes to buy a leg, &c. of ſheep he ſells for ſlaughter, in order to examine this circumſtance; and by recurring to the race ſuch were of, he may gain uſeful intelligence.

extreme. It is alſo a perfection in a ſheep, when lean, to have a thick, broad tail; the ſkin ſhould be of a bluſhing red, and the wool ſoft and fatty to the touch. He ſays, as the depth or length and fineneſs of the wool of ſheep, depend entirely on the race, feed, &c. thoſe circumſtances are the criterions to judge from concerning theſe matters; and begs leave to recommend it as a matter of the higheſt importance to every breeder and feeder of ſheep, to chuſe thoſe kinds which his land will well ſupport. Hence he ought never to buy either for breeders or for the purpoſe of fattening, from better feed than his own.

THERE are ſix or ſeven diſtinct races or kinds of ſheep in *England*, and from them every one may be ſuited: *viz.*

I. The *Lincolnſhire* breed; a tall, heavy ſheep, mounted on long flat legs, fit to carry them over marſhes, &c. on which (eſpecially the ſalt-marſh) they thrive beſt. Their wool is very deep, but in general hairy and coarſe; and conſequently, although the fleece draws a great weight, its inferior quality brings it to the average value of other fleeces.

THE fleſh of this race of ſheep is very large of the grain, on which account it is uſually kept ten days or more in the *ſafe* before it is cooked, which not only renders it tender and juicy, but exterminates the rank woolly taſte it has when new ſlain.

II. The *Yorkſhire* breed.—Theſe are large boned and tall, but ſhorter than the true *Lincolnſhire* breed, both in carcaſe and wool; their peculiar property is hardineſs of conſtitution.—This ineſtimable quality renders them the leaſt liable to the rot of any breed of ſheep he has been able to diſcover; and therefore,

fore, beyond compariſon, the moſt ſuitable for that and ſome of the adjacent counties; as well as all others which conſiſt of low lands, ſmall incloſures, and where the ground they depaſture upon is often top-dreſſed with dung, &c.

THERE is in the county of *Devon*, a breed not unſimilar to this, called the *Dart-moor Nats*;* the only difference is, they are ſhorter in the wool, and thinner carcaſed, which is probably the conſequence of being fed in an inferior way; being left to collect a coarſe and ſcanty ſubſiſtence on wolds and marſhes, which afford little elſe but heath and reed:—yet when they are taken to the home-lands, watered meadows, &c. they fatten incredibly, and ſeldom prove unſound. Hence they are neither improper nor unprofitable ſtock for ſuch a ſituation; but their meagre appearance while conſigned to the commons, ſays our friend, makes a ſtranger wiſh ſome improvement on thoſe huge waſtes may ſoon take place.

PERHAPS, *Agricola*, we can aſſign no better reaſon for that hardineſs of conſtitution peculiar to this, (the *Yorkſhire*, and other large breeds of ſheep) than their being, if not the next gradation on the ſcale of animal creation to neat cattle, that they are, to all appearance, and from divers circumſtances, but a very few removes therefrom.

FOR inſtance, their gait, their cloathing, their fleſh, and their food, are more like thoſe of neat cattle than any other breed of ſheep, or other animal yet known; their lungs, diaphragms, and blood are alſo as ſimilar as the ſize and diſtinction of a different ſpecies of creatures can well admit; and theſe

* *Nats* is the word the *Devon* people uſe to ſignify a ſheep without horns..

theſe indicate that the ſame degree of atmoſphere, or nearly ſo, ſerves for both:—whereas moſt of the ſmaller breed of ſheep, (which are as much the natural inhabitants of the mountains as theſe are of the valleys) have lungs of a much more delicate texture, and their diaphragms are calculated for reſpiring in a lighter atmoſphere than at any time is felt in the valleys.

THESE being facts which will bear the teſt of experiment, *Agricola*, we may venture to reſt a theory of the rot in ſheep upon them; and in order to ſave the opportunity, we ſhall leave the further deſcription of the other breeds of ſheep a little behind.

LET us, then, in the firſt place, *Agricola*, take under conſideration the unavoidable ſpecific difference of the atmoſphere in reſpect to its moiſture and dryneſs, its weight and levity, its ſalubrious and noxious qualities, &c. at different heights or altitudes, and attend to their conſequences.

Now as great quantities of humid particles are diſſipated by the heat of the ſun, &c. and carried up by the air from the ſurface of the earth, it inevitably follows, that the atmoſphere muſt be moſt moiſt next the ſurface of the earth: we need but reflect on the nature of dews and miſts, *Agricola*, to receive full conviction of this aſſertion. And with reſpect to the ſtate of its weight and levity, the *Toricellian* experiment, or the principle on which the barometer is founded, clearly decides, that air is heavier in valleys than on the top of mountains.

Agric. I THINK, Sir, it muſt be ſo from the effect of gravity; for as air conſiſts of particles, one will impinge on another in a manner ſimilar to the particles of water and other fluids, which, by experiments, we find to be very conſiderable.

Phil.

Phil. You muſt have credit for this inſtance of compariſon, *Agricola!* Gravity undoubtedly does affect a column of air as well as a column of water ;—there is indeed a diſtinction to be made with reſpect to their compreſſibility ; the former being compreſſible, and the latter incompreſſible ;—but this doth neither add to, nor diminiſh the effect of gravity ; and therefore a perpendicular tube filled with the atmoſphere, and exhauſted receivers put over cocks of equal capacities, but at different heights, would diſcharge quantities of air in the ſame ratio that they would diſcharge water, *&c. viz.* exactly as the ſquare root of the columns reſpectively.

And laſtly, to determine whether the atmoſphere abounds more with noxious matter in valleys than it doth in great heights, ſuch as environs downs and uplands, we need only attend to the ſtate of its humidity in thoſe ſituations ; for in the humid particles is the contaminated or noxious air inveloped, becauſe in that ſtate it is beſt adapted to vegetative uſe ; which uſe is undoubtedly the means the Author of Creation has appointed for reclaiming air contaminated by animal breathing, putrefaction, fire, *&c.**

You

* The firſt inſtance I had of this great manœuvre of Nature, was in a colliery, (*Holburn* in *Northumberland*) viz.—Having an occaſion to make a wear to turn a feeder of water to the pump-well, a quantity of turf, &c. was ordered from the bank ; the air in the cell or working-room (called the water-head) where the wear was to be made, was very ſoft or humid ; ſo much ſo, that a candle ſcarce could live in it ; a few days after the wear was made, the air cleared up, and candles burned vigorouſly in it ; and to my great aſtoniſhment, the herbage on the turf increaſed in verdure and ſize with great rapidity, notwithſtanding it was continually ſoaked in coal water. ——I therefore concluded, that the diſſipated particles of the candles, &c. which ſaturated the air, were abſorbed by the ſoil of the turf, and vegetation of its herbage

You will be careful to obſerve, *Agricola*, that although vegetables thrive well, if not beſt, in air ſaturated with moiſture and antiquated particles; that animals, on the contrary, have their health much impaired under ſuch predicament. The reaſon of which, very probably, is, thoſe particles are communicated to vegetables as food, and are digeſted and aſſimilated by a due proceſs into the nature of the plant:—whereas with animals under the ſame predicament, they are conveyed through the *glottis* into the lungs, and there mingle with the blood, without any previous change or correction. Hence the heterogeneous matter contained therein, excite commotions in the vital fluid; and as the air was ſaturated with moiſture when reſpired, it is incapable of imbibing the fuliginous vapour which ought to be expelled from the blood by expiration; and therefore inevitably muſt corrode the lungs, make them a proper nidus for the eggs of animalcula that are floating in ſuch air, diſſolve the blood, and ſoon put an end to life.

IT is true, Nature makes many efforts to ward off the conſequence; and therefore it doth not (unleſs when the cauſe amounts to ſuffocation) occaſion immediate death; but unleſs the primary cauſe is removed, it will gain a-pace.——

thereon. I attended ſtrictly to this idea for ſome time, in order to eſtabliſh a theory for rendering the contaminated air in mines vivacious; and received ſuch ample conviction from experiments and obſervation, that I advertiſed to be called upon to try the fact in large, for the benefit of my fellow-creatures conſigned to ſubterraneous regions, (*ſee Mr* Young's *Tour to the North of* England) but did not find any invitation; and as my ſituation now puts it out of my power to attend ſuch, I take this opportunity to beſtow the hint on the public.

The common means which Nature recurs to in thoſe caſes are, perſpiration, purging, and ſuch like evacuation. But, as I ſaid before, if the original cauſe is not removed, none, nor all of thoſe means can prevent, but for a while, the ruin of the creature:*—however, whatever Nature points to in the cure of a diſorder, *Agricola*, ought to be regarded; hence, if the rot is not too far gone, by ſhifting the creature into pure dry air, and wholſome food, and adminiſtering a few doſes of manna to each, and allowing them to feed a few minutes on green parſley every day for three or four weeks, will very much facilitate their recovery.†

Agric. I OWN, Sir, the upland ſheep, when they are brought to the valleys, are ſooner affected with the rot, than the native low-landers are; but this I have, with many others, attributed to the different qualities of the herbage, rather than that of the air.

Phil. I AM ſenſible bad herbage, *Agricola*, and alſo the want of a convenient quantity of food, are highly detrimental to

* THE ſkins of ſheep are leſs porous than moſt other animals, and conſequently they cannot perſpire ſo freely by ſweating. It is not improbable that Nature avoided that mode of perſpiration to preſerve the wool; for if they had as copious a perſpiration by ſweat as the horſe, their wool would ſoon be deſtroyed thereby; neither would their ſkins, if porous, have been ſo proper to a ſtate of perpetual expoſure to the viciſſitudes and ſeverities of the atmoſphere. Sheep perſpire chiefly by expiration.

† THE parſley is a powerful diuretic; and the manna (taken about the ſize of a hazel nut at a time) keeps up a due motion in the bowels, by which means the offenſive matter is drained from the blood; and if their noſtrils are held over a pan of live cinders (on which a little common turpentine and ſtone brimſtone are caſt) three or four minutes, morning, noon, and night, while the above courſe is performing; and the creatures kept dry, and allowed a convenient quantity of oats, mixed with wheat chizel, there need be little fear of them, if taken in time. The fumigation has a tendency to kill the *vermiculi*, and heal the ulcers of the lungs.

to theſe creatures; and do aggravate the great impediment heretofore mentioned, but I cannot admit ſuch as principals in that malady. When you have thoroughly conſidered the force of the inconveniences heretofore mentioned, *Agricola*, with reſpect to the moiſture and contamination of the atmoſphere in valleys and marſhes; its ſuperior weight in ſuch a ſituation, to what it is on uplands; and the diſtreſs ſuch a ſuperiority of external preſſure draws on thoſe tender creatures, when they are not the natural inhabitants of ſuch ſituations, and conſequently have not the organs of reſpiration, &c. ſuited thereto; you will, I preſume, be more ſurprized that they live one month under ſuch an alternative, than that a few die every year.—Much might be ſaid in ſupport of what has been inculcated reſpecting the above theory of the rot or decay amongſt ſheep, *Agricola*; but as what has been ſaid is ſufficient data, I think the beſt way to eſtabliſh it with you, is to leave it to your own contemplation and experience. In the mean time, however, do not neglect to give your ſheep (whether they be high-landers or low-landers) eminences to lodge on at night, if ſuch you have. If you have not ſuch convenience, and ſtock your farm with ſheep, the friendſhip I bear you obliges me to tell you, you ſtock improperly. And now I will proſecute the deſcription of the different races or breeds of ſheep, in the order heretofore propoſed, if you think proper.

III. THE *Leiceſterſhire* or midland breed. This breed, with reſpect to ſhape, much reſembles the ram I have deſcribed, and bears a tolerable quantity of wool, which, by its fineneſs, more than compenſates for its falling ſhort of the *Lincolnſhire* and *Yorkſhire* fleece in weight and length of pile. The mutton is alſo finer, and they in general make greater progreſs in fattening; nor do they require ſuch a deep paſture.—It is, neceſſary,

however, to remind you, *Agricola*, they are neither ſo well calculated for moiſt paſture nor moiſt air as thoſe are.

IV. THE *Dorſetſhire*, *Wiltſhire*, and *Somerſetſhire* breeds are very ſimilar in ſize, wool, ſhape, and other peculiarities. They are ſmall, but well made ſheep, and bear a very fine, ſhort wool; are fruitful breeders, and their ſeaſon of lambing, when properly kept, is in *December*; on which account moſt of the houſe-lamb is fed from thoſe breeds; the ſheep, when of age, feed very kindly, and the mutton is exceeding nice; they are natives of downs and uplands, and are therefore by experiments, as well as our theory, deemed unfit for low lands.

V. THE *Herefordſhire* breed. Theſe are remarkably ſmall ſheep, both in carcaſe and wool; both of which are no leſs remarkably fine in quality:—they require a ſound, dry paſture, on which they will fatten, although the graſs be ever ſo ſhort.

VI. THE *Northumberland* original breed. Theſe are of a ſize between the *Leiceſterſhire* and *Dorſetſhire* breeds; and the quality of their mutton and wool are alſo a medium between that of thoſe breeds, and are, in point of conſtitution, next to the *Yorkſhire* breed; from which they live to a full age, and ſeldom deceive the butcher, or thoſe that purchaſe them to graze on lands that are a medium between high and low, or to feed down turnips, &c.

THERE are others, *Agricola*, in various parts of the kingdom, that are ſomewhat different from any of thoſe breeds already deſcribed; but the difference is ſo immaterial to our purpoſe, that

that we may warrantably omit any further diſtinction of that ſpecies of animals.

I HAVE little more on this ſubject, *Agricola*, to advert to you, but that the ſhape of the ewe ſhould (as far as the ſize and ſex can admit) coincide with the ram above deſcribed, except the neck and back; the ewe's back, on account of the burden ſhe carries when with young, requiring to be rather a little convex than ſtraight; and as ſhe needs not, like the ram, a ſtrong large neck, (for defence and offence) the ſmaller hers is, the better; provided it be ſufficiently ſtrong to bear the head in a ſprightly attitude.

THE next ſpecies of animals, according to our method, to be deſcribed, are Swine; and as there are alſo different races or kinds of them, I ſhall (according to our friend's direction) diſtinguiſh them, and leave you the criterion of their perfection of ſhape, &c. And firſt of the common hog.

THIS breed, from its anſwering either for bacon or pork, as the age ſuits; and its thriving on animal or vegetable food, either promiſcuouſly or ſeparately, very probably, ſays our friend, gave riſe to the name of this ſpecies of ſwine. It is in general, of all others, the largeſt breed of this country; but in different counties the ſize varies conſiderably:—but this very probably proceeds from the quantity of care and provender beſtowed on the breed for a ſeries of years:—however thoſe that purchaſe, certainly do beſt when they buy thoſe that have been well kept, and ſee that they have plenty to eat and drink, and are well aired and kept clean after they have them. He ſays plenty; but at the ſame time, on every account, forbids exceſs, even when at grazing; for, he ſays, ſwine, though they

they have voracious appetites, are very liable to take ſurfeit, when they have deep feed of any kind, if care is not taken to portion out their food, and time of faſting; and orders, that even when they are at graſs, that they be put in the fold or ſtie frequently, if the feed is deep.

IT ſeems ſomewhat ſtrange, I own, *Agricola*, that any creature ſhould be put out of the hand of Nature, without any neceſſary check for its preſervation; let us, therefore, examine carefully every liberty man uſually takes with thoſe creatures, before we either arraign the hint our friend gives relative to the management of them, or preſume to think we have detected Nature in an error.

Agric. IT is not improbable, Sir, our preventing them to dig with their noſes, (by rings being fixed thereto) hurts their digeſtion; for I have often obſerved, that when they can dig, they grow faſteſt, all other circumſtances being equal.

Phil. I BELIEVE you have beggared the enquiry at once, *Agricola*; for beſides the aſſiſtance that exerciſe gives to digeſtion,—the worms they take being filled with earth, ſand, &c. ſerve them in as good ſtead to facilitate digeſtion, as pebbles do the digeſtion of pigeons; hence it is they return immediately to the trough or paſture, with new appetite. Whoever, therefore, keeps herds of ſwine, and wants to have them feed or grow faſt, ſhould (if they will prevent them aſſiſting digeſtion in the way Nature has directed) mix with their food ſuch ingredients as will effectually promote it, *viz.* ſand, cinders, &c.—And as the ſtomach of the hog is leſs muſcular than moſt other creatures, and conſequently not only requires the above aid to facilitate digeſtion, but the food approaching to a putrid ſtate,

it

it therefore ſeems neceſſary that all grain thrown to them be malted, all roots and fruit be ſtale, all milk changed, and that all blood and animal ſubſtances be kept ſome time before given to them. But although a little experience, *Agricola*, has not been able to contradict this theory, but rather has favoured it, —it may not be improper, however, to try it further, before we ſet it up as infallible:—you will, therefore, I hope, uſe precaution and in the end profit by the hint.

THE breed of ſwine I have been deſcribing, is generally choſen by farmers to feed on clover, &c. in the ſummer, and to glean their ſtubbles, woods, orchards, and folds in autumn and winter, until they arrive at ſixteen or eighteen months, and then they are put to eating corn (peaſe is the beſt) in order to harden the fat, and complete them for bacon; and of all the breeds I have ſeen, ſays our friend, they are the beſt ſuited to that purpoſe; and are in the beſt condition and ſize in *Hampſhire* and *Leiceſterſhire*, of any counties in *England*. But this circumſtance, as was before obſerved, ſeems to center in the peculiar care and food the good people there beſtow on them. The beſt ſhaped of this breed, are thoſe with long and broad backs, deep flat ſides, and broad and thick hams, thick necks, and long ears, large feet, long in the quarter, and pretty high; and, until they are come to their full growth, and thoroughly fatted, always appear beam-backed.

THE Wild Hog.—This kind is much ſmaller than the above breed, but otherwiſe not unſimilar to it, except in its roundneſs of body, ſhort ears, and reſtleſs diſpoſition. It is, however, for poor people in country places, certainly the moſt ſuitable, as it will fatten at little expence; and by the ſhock,

ring,

ring, &c. be rendered inoffenſive to the neighbourhood; and for pork they cannot be exceeded;—hence they claim a proportion in the ſtock of every farmer, &c.

LASTLY, The all-belly Hog, as it is called.—This kind is remarkably ſhort bodied and ſhort legged, and as remarkably deep bellied; and the beſt ſort are not leſs remarkable in the broadneſs of their ſhoulders, backs, and chines:—and as they are the leaſt choice infood of all the hog kind, and eatmuch, they are ſeldom out of condition, unleſs food is not to be had. They are great breeders, and exceed all the other breeds for roaſting pigs, and are alſo valued both for porkers and bacon. They may therefore be recommended as ſuitable ſtock, at leaſt in part, to conſume the offal of dairies, ſculleries, mills, breweries, &c. &c.

THERE are ſome ſwine to be found that do not anſwer theſe deſcriptions, *Agricola*, but ſuch are produced by croſſing; a practice in every inſtance reprehenſible; becauſe no fair experiment has been produced to evince its general utility; and becauſe it is an attempt to reverſe that law of Nature which conſtitutes a diſtinction of breed. It is not, we own, *Agricola*, quite ſo heinous, nor is it ſtigmatized with ſuch evident marks of the Creator's diſapprobation, as putting the horſe to the aſs, &c. is; becauſe, in ſuch caſes, the offspring are curſed with total barrenneſs, and conſequently an effectual ſtop put to any further innovation. But by the ſame parity, it is reaſonable to expect that, as croſſing the breed is an innovation of a law of Nature, it muſt at leaſt entail a taint proportional to that innovation.—But this by the by.

THUS

THUS you ſee, *Agricola*, notwithſtanding the rearing and fattening of hogs is a very intereſting part of huſbandry, the theory or rationale thereof, according to our friend's explanation, conſiſts but of a few particulars, *viz.* 1ſt, To adopt the kind or breed which beſt ſuits the feed, ſituation, and purpoſe. 2d, As Nature has given them inſtinct to dig with their noſes, in order to collect ſuch ingredients as facilitate digeſtion; if ſuch digging becomes a nuiſance to their owner or his neighbourhood, and therefore muſt be reſtrained, it behoves the keepers to mix with their food ſuch things as will promote digeſtion. And, 3d, As in a ſtate of Nature they travel and hunt for their prey or food, conſequently are in no hazard of ſurfeiting or over-eating themſelves, notwithſtanding their voracious appetites; which ſort of appetites Nature probably ſaw convenient to endow them with, in order to excite induſtry in their unweildy carcaſes;—but when they are fed in ſties, &c. it behoves keepers to portion out their food and meal-time, to prevent ſurfeit. 4th, As their ſtomachs abound with ſanguiferous veſſels, and ſmall glands, and for reaſons already given, it amounts to more than a conjecture, that they ought not to faſt too long, and that they ſhould have food which digeſts quickly; and therefore ſuch treatment of it as above deſcribed, *viz.* to bring it to nearly a ſtate of putrefaction before they have it, muſt be ſerviceable. 5th, As ſwine that are confined to feed and ſtye in low moiſt places, ſeldom thrive, but on the contrary, often die with decayed lungs, infeſted (like the lungs of rotten ſheep) with a vermin commonly called flukes;—they ought, therefore, to be kept in dry, well littered ſties, and to breathe in freſh dry air. 6th, Reſpecting the time of life they breed to, (the greateſt advantage) they bear no exception from the general rule, *viz.* that at the prime of life the

offspring is ſtrongeſt, *cæteris paribus*;*—and laſtly, as this ſpecies of animal is viviparous, the females intended for breeders ought to have plenty of large teats.

THERE are a variety of other creatures, *Agricola*, ſuch as goats, rabbits, geeſe, hens, turkeys, pigeons, &c. which fall under the huſbandman's guidance, and may yield him conſiderable profit; but ſuch *minutiæ* doth not altogether comport with our plan; eſpecially as a competent attention to the other theories we have, and hereafter ſhall have occaſion to explore, may direct any one to what is moſt convenient in the management of thoſe creatures, without giving in this place any further directions. The ſubject of our next converſation, *Agricola*, (to purſue the method propoſed) will be to diſcuſs that part of our theory which relates to the due care of the organization and ſtamina, or firſt principles of plants.

Agric. FOR which purpoſe I ſhall be careful to attend you, Sir, if permitted, on my return from market to-morrow evening; the neceſſary preparation for which obliges me at preſent to wiſh you, thus abruptly, good night.

Phil. I SHALL then and ever be glad to ſee you, *Agricola*. ——Adieu.

* WHEN the ſow is lean and healthy, and the boar ſtrong, the greateſt number of pigs is uſually produced.

CON-

CONVERSATION XI.

PHILOSOPHUS.

I HOPE you met with nothing diſagreeable at market to-day, *Agricola*, and that I ſee you well.

Agric. I AM very well, Sir; nor did I meet with any thing diſagreeable at market directly in my own concerns; but I heard ſome diſagreeable altercation between a ſeller and buyer of corn, relative to its meaſure. The former inſiſting his peck was full *Wincheſter*; and the latter, that his was conformable to the peck of the corporation, and therefore, as there was a deficiency in the ſeller, he ſhould make reparation. In the end, I believe, the ſeller (rather than become the object of ſuch an unpopular argument) did make an abatement, but thought himſelf hardly treated; eſpecially as his peck had the ſtamp of two other neighbouring corporations to authenticate it. I took the depth and diameter of it, Sir; and ſhall be greatly obliged to you in directing me to find the content of it, and what the law relative to corn meaſure is.

Phil. I DO not pretend to be a lawyer, *Agricola*; but as ſuch an enquiry is not altogether foreign to your buſineſs, I ſhall aſſiſt you all I can in that matter, before we proceed as premiſed laſt night.

KNOW then, *Agricola*, that by *Magna Charta*, c. 25, there ſhall be only one common meaſure for corn and meal, *viz.* that kept

in the King's Exchequer, which correſponds to that commonly called the *Wincheſter* buſhel; and conſiſts of four pecks, each peck of two gallons, and each gallon of 272 cubic inches and one-fourth. Whoever ſhall keep any other meaſure by which any thing is bought or ſold, is to forfeit five ſhillings for every ſuch offence; by the 17th *Car.* I. c. 19.——Your neighbour, therefore, did wrong, *Agricola*, in making any diſcount, if his peck was up to the *Wincheſter* peck, as he pretended. But what were the dimenſions?

Agric. THE mean diameter, Sir, was ten inches and a half, and its depth ſix inches and a half.

Phil. THE circumference would therefore be 33 inches; for as 7 is to 22, ſo is the diameter of every circle to its circumference; and the rule to gauge any veſſel of that form is,—Multiply half the circumference by half the diameter, and that product by the whole depth; then divide the ultimate product, if corn gallons are required, by 272·25 (if ale gallons, by 282, and if wine gallons, by 231) the quotient gives the number of gallons and parts thereof the veſſel contains. But as you can handle numbers, *Agricola*, give us the operation.

Agric. By decimals, half the circum. is 16·50
and half diameter 5·25

product 86·6250
depth 6·5

Cubic inches in a corn gallon 272·25)563·06250(2·068

The quotient, Sir, is 2 gallons and ·068 parts of a gallon.

Phil.

Phil. THE peck, then, was not only up to the Exchequer and *Wincheſter* pecks, *Agricola*, but a fraction over it; and ought not, as I ſaid before, to have been found in default. On the contrary, it is more than probable, the perſon that ſells by ſuch a peck, is more a friend to corn-buyers, than the perſon that ſells by a larger one.——My reaſons are briefly theſe:—1ſt, Becauſe over-meaſure is a decoy or ſtratagem to bring cuſtomers; and every perſon that knows the nature of bargaining, will own, that the more cuſtomers, the eaſier it is to raiſe the price. And I may venture to ſuggeſt, that the perſon who has the addreſs thus to cajole cuſtomers, may be thought capable of raiſing the price under the ſpecious pretext of great meaſure. 2dly, As there is a regiſter of the prices of corn publiſhed, ſuch advance in price becomes known throughout the kingdom; the conſequence of which, I will ſuppoſe, muſt be an advance of price, even with thoſe that ſell juſt meaſure; for we cannot ſuppoſe that thoſe people will aſk below the current price. 3dly, And when the people who ſell by juſt meaſure, have come up to large-meaſure-men's former prices, it would be believing the latter to act very inconſiſtent with their own principles, if they did not again uſe their old argument, and alſo their uſual moderation. Thus a continual advance of price may happen, under the falſe biaſs of a few individuals ſelling over-meaſure.

Agric. BUT prices do not continually advance, Sir?

Phil. THAT, however, doth not render the fact invalid, *Agricola*; for there are a variety of things, ſuch as large importations of grain, full markets, want of money, &c. which act as checks on the advance of price, and obtain againſt every biaſs; even the reaſonable and laudable one of ſuperiority of quality in grain;

grain.——But you muſt excuſe my diſmiſſing this argument, *Agricola*, as it in ſome meaſure breaks into the method propoſed, which was to explore the theory of the due care of the ſtamina, or firſt principles, and organization of plants.

To proceed, therefore, as propoſed, it may not be improper, in the firſt place, to take a retroſpect of what has been diſcuſſed relative to the affinity ſubſiſting between the animal and vegetable kingdoms.*

Agric. I REMEMBER the minuteſt circumſtance, Sir; and am convinced that affinity demonſtrates (as far as there is a poſſibility) an entire ſameneſs.

Phil. YOUR aſſiduity and memory, *Agricola*, ſuperſedes the neceſſity of a repetition; hence I may at once tell you, that as every judicious breeder makes a principle of having ſubjects to breed from, exempt from every natural blemiſh, and in a thorough good ſtate of health; which principle or axiom is enforced and corroborated by ſucceſsful experience; and its reverſe ſeldom fails to bring repentance, in as much as frail ſickly progenitors almoſt continually produce a puny underrate offspring.

INDEED nothing ſhort of a miracle can reverſe the effect; becauſe it clearly appears, that the adorable Creator thought proper (in order to prevent the neceſſity of new creation) to implant in the ſtamen of every ſpecies of creature, the power of ſecreting certain juices of the body, (when arrived at maturity,

* THAT affinity is ſtated page 57 to 62.

rity) which, when conjoined according to the laws of procreation, ſhall conſtitute a creature or creatures of the ſame ſpecies and ſimilitude of the progenitors.—Hence, if the progenitors are healthy, vigorous, ſtrong, well formed, &c. except in caſe of accident, the offspring cannot be otherwiſe; and *vice verſa*.

Now, as it is conſiſtent both with theory and experience, *Agricola*, to appoint the healthieſt, ſtrongeſt, and beſt formed of every ſpecies of animals, for breeders; and as we cannot doubt of the moſt intimate affinity ſubſiſting between the animal and vegetable kingdoms,—it follows, that the ſeeds of vegetables which are beſt formed, healthieſt, and leaſt tainted, of all others are the propereſt for breeders;—and this, *Agricola*, is briefly what is meant by attention to the ſtamen and organization of plants.

BUT as a criterion for the choice of ſeeds muſt be peculiarly intereſting to your aſſociation, as well as to every individual in the ſcience of huſbandry, we ſhall illuſtrate the above general critera by familiar compariſon, and make ſome application.

FIRST, then, as the fœtus in the womb of an animal receives nouriſhment, until a voluntary conſent of Nature is proclaimed for its expulſion;—ſo likewiſe, the ſeeds of plants muſt receive nouriſhment in the ear, until Nature proclaims their further ſupply either unneceſſary or impracticable; and this ſhe does, by a retrogradation of their conſtituent parts. Therefore, to give the ſeeds the beſt chance, harveſt cannot be warrantably attempted, until the ſtraw and leaves are palpably incapable of communicating further ſupply; which incapacity is always indicated by a yellow or whitiſh taint on both. This criterion of harveſt, although generally known, is too little attended to;

ſome

ſome deferring beyond, and others ſtepping to before its appearance;—yet both are moſt certainly wrong:—for the ſeeds are no more to be expected to improve in the ear, after the ſtalks and leaves have loſt their verditure, and begin to be ſhrivelled, than the fœtus may be expected to grow in the womb, after the *funiculus umbilicalis* is decayed:—and the hazard they are in of being beat out by winds, or rotten by rains in the latter harveſt, is of too ill conſequence to be connived at. Let me intreat you, therefore, never to harveſt ſeeds of any kind, until theſe ſymptoms appear, nor defer it long after.

SECONDLY, as a ſmooth clear ſkin, indicates an animal to be in a good ſtate of health and condition, ſo it is likewiſe a teſt of corn being healthy and proper for ſeed, provided it has no unpleaſant odour.* If it has, reject it with the ſame earneſtneſs you would a glandered ſtud, or that a planter would peopling his colony with ſubjects totally infected with a *lues venerea*. For if it has that odour, it moſt certainly is under the diſeaſe called *ſmut* or *flay*; which diſeaſe doth not only render thoſe grains that are totally ſlain, incapable of reproducing; but by their becoming a neſt of vermin, every grain that comes into contact with them, receives more or leſs damage, in proportion to the quantity of thoſe vermin, or the juices it yields, which they receive.

Agric. I AM convinced, from coſtly experience, Sir, that the diſeaſe you mention ought to be guarded againſt with the ſtricteſt diligence; and hope you will favour me with your ſentiments relative to its cauſe, and remedy, if there is any.

* THE odour I mean of reſembles that of ſtale fiſh.

Phil. As far as I am able to aſſiſt you in that matter, I ſhall chearfully comply.

Know then, *Agricola*, that I am thoroughly convinced by experiments, that wheat kept in a moiſt place, acquires the odour I have mentioned, notwithſtanding it was entirely free of it when put into that ſituation; and that the crop it yielded was tainted:—whereas an equal quantity of the ſame wheat, which had not been depoſited in ſuch moiſt place, neither acquired that odour, nor was its produce tainted, although the ſoil, ſituation, &c. were the ſame.* Now as this odour is a concomitant of wheat that invariably produces crops tainted with that diſeaſe; and as all odour is occaſioned by the diſſipation of the oils and ſpirituous principles of the body that emits the odour; it follows, that at leaſt part of the oil and ſpirit of the ſeeds kept in a moiſt ſituation, are diſſipated and carried off;—and as no other impediment except moiſture has intervened, that the moiſture is the efficient cauſe of ſuch diſſipation of the oils and ſpirituous particles, and conſequently of the diſeaſe.†

Agric. BUT ſuppoſe a moiſt ſituation to have the effect of diſſipating the oils, &c. of thoſe ſeeds, by occaſioning a ſlight fermentation, or by any other means, I do not underſtand why the ſtraw and every member of the plant are not impaired, as well as its ſeed?

* THIS declaration is the reſult of repeated trials in various places of *England*, at different times.

† THERE is the greateſt probability that ſuch ſpirituous principle is nearly allied to, if not electrical fire itſelf, and therefore is a fit conductor.

Phil. I OWN, *Agricola*, ſuch a conſideration may ſuggeſt a ſuſpicion of the validity of the above theory, if the ſtructure and œconomy of the ſeed is not minutely attended to.—Know therefore, that the moſt volatile oils which the ſeeds contain, are depoſited round the embrio plant, in order (no doubt) to defend its tender organs from injuries. If, then, the oils themſelves are diſſipated by moiſture, the organs of generation of the plantule, being moſt exquiſitely delicate, muſt receive injuries:—and I think we may truſt ſo far to the analogy between animals and plants, as to take it for granted, that a plant may acquire as large a body without the organs of generation as with them, as well as animals, and that they are equally deficient in point of re-production when thoſe organs are injured.† And this, *Agricola*, is my idea of the cauſe of ſmut or ſlay in wheat; a diſeaſe for which there is no remedy, but may with eaſe, in many inſtances, be prevented.

Agric. I DO not only feel conviction from your explanation, Sir, but it has brought to remembrance ſeveral circumſtances which corroborate your idea; particularly that in this neighbourhood, ſince there have been good barns and granaries made, there have not been ſuch large quantities of ſlain corn, as there were before that period; eſpecially ſince, and where the winnowing

† THE degree of barrenneſs or ſmut, probably is always proportional to the degree of injury the genital organs and ſpirituous principle have received; the latter being as neceſſary, as a *punctum ſaliens*, to move thoſe minute organs, as they themſelves are neceſſary to tranſmit or receive the *farina fecundans*. Whoever will pleaſe to attend to the flowering of wheat, (or blooming, as it is ſometimes called) may receive teſtimony of this aſſertion; for thoſe ears that do not flower, and conſequently never preſent the exterior organs of generation to our view, always prove entirely ſmutted, and thoſe that do it faintly are often found tainted.

nowing machines have taken place of the old mode of winnowing.*

2d, THAT it is in those seasons when there is so little moisture in the soil, that the seed cannot vegetate for a long time, that the crops are most injured by the smut. Hence, I conclude, that although there is not moisture enough to occasion a fermentation in the juices of the seeds, sufficient to promote vegetation, yet it may be sufficient to dissipate part of the oils, &c. therein contained, and to injure the young plants.—I am therefore determined, in future, to defer seed-sowing until the land is sufficiently moistened to support vegetation with vigour.

3d, THAT as poor cold land is most addicted to smut, every thing else being equal, I strongly suspect that the seed lying so long in such land before it vegetates, occasions it. I am therefore of opinion, that all such lands should be sown early in the autumn, as the heat the land has acquired by the summer sun would then facilitate vegetation; for I do not find that cold land ever wants moisture enough, if it has heat enough.

4th, THAT I have constantly observed nearly the same appearance in corn long kept in a moist barn after it was threshed, and that taken from amongst the clods before the plant appeared, when its vegetation had been kept back by a deficiency of moisture or heat.† Hence, instead of heaping seeds of corn, especially wheat, upon an earth or lime floor, where neither the sun-beams nor free air has admission, I intend to spread

* *Viz.* WAITING for the wind blowing through the door-ways of the barn, which sometimes did not happen for a month after the corn was threshed.

† THE downy ends incrustated with a grey mould.

thoſe ſeeds thin on a well air'd upper chamber, and paſs them through the winnowing machine every ten days after they are threſhed, until they are ſown; which, I preſume, ought not to be at a great diſtance from the time of threſhing them out; and ſhall ever be particularly careful that no ſlain be depoſited with them either in the chamber or in the field.

Phil. I PROTEST, *Agricola*, you philoſophize ſo incomparably, and do comprehend my theory with ſuch clearneſs, that there remains not the leaſt ſhadow of neceſſity to proſecute the enquiry to any greater extent.

Agric. BUT what muſt I do with reſpect to ſteeps, Sir?

Phil. LET them alone, *Agricola*, except of rain, river, or ſalt water. The principal uſe of ſteeps is to ſeparate lean and unfecundated grains from the proper ſeeds, by cauſing the former to ſwim in a vat, (while the latter ſink to the bottom) whence they may be ſkimmed off without difficulty; and if the water is immediately let out, and as much quick lime dridged on the ſeeds as to candify every grain, they will ſow the better for it; nor will I pretend to diſpute its having a tendency to prevent, by ſuch incruſtation, in ſome meaſure, the baneful effects of moiſt vapours, &c. The ſeed ought to be ſown ſhortly after, however; leſt the cauſtic quality of the lime break the rind.——As to copperas, ſulphureous, nitrous, and ſuch like ſteeps, as they can do no good, (ſuppoſing they do no harm, which, by the by, I am of opinion is ſuppoſing too much in their favour) avoid them, if it were but to ſave expence.

Agric. IF it is not diſagreeable to you, Sir, ſhould be glad to know your opinion on the cauſes and remedies for the diſeaſes called mildew, blight, ruſt, &c.

Phil.

Phil. THOSE diſeaſes, though much leſs pernicious than the ſmut, yet, like it, have not a remedy after they have once taken place; but means may, and ought to be uſed to prevent them. And as they are principally occaſioned by an obſtructed vegetation, the moſt likely means to prevent them are ſuch as keep it up uniformly, *viz.* manuring and otherwiſe cultivating the lands properly, and ſowing the beſt ſeeds, and in the beſt ſeaſons:—and perhaps ſome aſſiſtance may alſo be made by feeding down the leaves in ſpring with ſheep, when they have become withered by the ſeverity of weather, &c. For as the leaves of plants, while they keep their verdure, do not only perſpire ſuch redundancies as offend, but likewiſe imbibe ſuch particles as promote the growth of the plant,*—if ſuch intercourſe is prevented by any means, (and their ends being withered, moſt certainly does) the ſtalks and ears in courſe will feel the bad effects. And this, perhaps, is not the only good end which feeding down wheat after winter, with ſheep, anſwers; for if the land is dry and light (if wet and heavy it is not to be attempted) they fix the roots, pick up weeds, and alſo give it a ſlight dreſſing. However, care ought to be taken, that they do not eat the corn too near the crown;—if they do, the loſs may be more than equivalent to the advantages they otherwiſe would ſecure to the crop.

Agric. FROM all which I clearly perceive, Sir, you hold a right huſbandry is the beſt ſecurity againſt thoſe diſeaſes.

Phil. I CERTAINLY do, *Agricola*; and the principle flows from the ſame ſource that influences a phyſician to preſcribe circumſpection and a due medium in all things, to thoſe who wiſh to preſerve health.

* SEE *Papin*'s experiments, &c.

Agric. YOUR opinion, Sir, on the nature and uſe of changing ſeed, would yield me much ſatisfaction, if you think it convenient at this time.

Phil. THAT you ſhall have, *Agricola*, as freely as you aſk it.—In the firſt place, I conſider the change of ſeeds as exactly ſimilar to the change of live ſtock; and as it is a fact eminently conſpicuous to attentive huſbandmen, that ſtock choſen from the breeds that have been for a length of time in plentiful healthy keeping; and the ſtock ſo choſen removed before they are made to depend on the ground for their ſuſtenance,* that they are more fruitful for ſome years, and their young make better progreſs, even where the feed is mean and ſcanty, than the cattle or ſtock that have been choſen from ſtock under a hard keep, and brought on an equal keep with them. And this, no doubt, is merely the effect of the ſtamina or firſt principle being vigorous; which peculiar vigour, theory (as well as experience) teaches will, in proceſs of time, dwindle off, if the keep is not augmented, as well in quality as quantity. But as in many inſtances no augmentation can be effected,—to ſuch the change of ſtock is, though a temporary, yet a ſalutary alternative; and ſo it equally is, to ſuch growers of corn, &c. as have not the beſt lands:—for they, like the breeders and rearers of ſtock on poor lands, may avail themſelves of the vigour of ſtamina, or firſt principles, of the ſeeds they have occaſion to ſow. And on this hinge, *Agricola*, depend all the common advantages of changing breeders, both in the vegetable and animal genus.

Agric.

* THE propereſt time to remove them is when they are weanlings.

Agric. AT this rate, Sir, thoſe who occupy good land need neither change their ſeeds nor breeding ſtock.

Phil. THEY are not under an equal neceſſity with thoſe that occupy poor land, I aſſure you, *Agricola*; yet it may be of ſervice to them ſo to do, if they change for better grain and better ſtock than their own; and provided they attend to the above rule reſpecting the latter, viz. that the breeders they receive have not been uſed to better feed than they remove them to:—and this rule ought to be attended to in the choice of plants of every kind, particularly if the plants are old; for it is not with plants and animals that have ſubſiſted long by their own endeavours, (if I may riſk the expreſſion) as it is with their embrios.

Agric. I NOW perfectly underſtand the matter ſo far, Sir; but are we not to give ſtrict attention to the nature of the land we receive our change from; that is, whether it be clay, loam, moſs, ſand, chalk, black mould, &c. &c.

Phil. So far as any of thoſe ſoils has the preference on account of ſupplying the greateſt quantity of food for the grain, and no farther, *Agricola*; for the complexion and texture of the ſoil is not the value of a mite either for or againſt the ſeeds that feed on it, in any other reſpect. Hence, as the quality of the ſeeds is the chief object, thoſe that have good ſeeds of their own ought to ſow them, unleſs they can be ſupplied with better. And as I have already ſhewn you what to avoid in the choice of ſeeds, with reſpect to their complexion and ſcent, I ſhall alſo give you the greateſt number of corns of the ſeveral common ſpecies of grain, that ought to be contained in a certain weight, if fit for ſeeds; and as gold weights are now in

every

every farmer's poſſeſſion, it may probably be proper to alter my former computation to ſome gradation therein, for the unit or common meaſure of this criterion.—Hence

WHEAT, miln dry, if fit for ſeed, ſhould only require 162 corns to be at leaſt a counterpoiſe to a full guinea, that is equal to 5 *pwt.* 9 *gr.*

RYE, miln dry and fit for ſeed, ſhould not exceed 256 corns to counterpoiſe a guinea.

BARLEY, miln dry and fit for ſeed, ſhould not exceed 178 corns to be a counterpoiſe for a full guinea.

WHITE oats, dry and fit for ſeed, ſhould not exceed 231 corns to counterbalance a guinea.

THE corns, in all the above caſes, ought to be taken up without choice; and unleſs they are in ſuch numbers, and (under ſuch circumſtances as above ſpecified) are reſpectively a full counterbalance for the common meaſure above mentioned, *viz.* a full weight guinea, I can aſſure you from experience, you will find yourſelf to blame, if you admit the parcels they were taken from as ſeeds.

LET theſe, therefore, be the higheſt numbers, and as ſeldom as poſſible admitted, even ſuppoſe you ſhould pay 50 *per cent.* more for ſeeds that will counterbalance the common meaſure in ſmall ernumbers, and are at the ſame time fair, ſweet, without blemiſh, and unmixed.

AND when you have purchaſed ſuch, *Agricola*, care and attention muſt ſtill be given to prevent their croſſing; for in the

the blooming ſeaſon, if they are not ſecured by diſtance or by a ſufficient partitioning, there will be an intercourſe which will mutilate the breed.——It is highly proper, therefore, when you have procured ſome fair, plump, unmixed ſeeds (for inſtance, of wheat) and want to preſerve their produce entire, to ſow them at as great a diſtance as you poſſibly can from any other wheat. I do not think a hedge a ſufficient partition or bar againſt the intercourſe I have mentioned; for when the wind is ſtrong, the farina fecundans, or male duſt, flies like ſmoke:—hence it requires particular means to be uſed to prevent ſuch intercourſe. Perhaps, when it can be done with propriety, a field of peaſe, turnips, or ſome different grain or pulſe intervening, will be a pretty good partition, eſpecially if a hedge or high ground alſo intervene. But it is as unneceſſary as it is impoſſible for me to mention the means you are to uſe in every ſituation to prevent this ſort of inconvenience; your own ſagacity is the beſt rule for that, now you are appriſed of the circumſtance.

Agric. If that, Sir, is the cauſe of our wheat, &c. falling off from its original colour, ſhape, &c. as I now ſtrongly ſuſpect it is, I ſhall in future uſe every precaution to prevent it.

Phil. It is the direct cauſe, *Agricola*; for as well may you expect your *Dorſet* ewes, in their flowering ſeaſon, to have intercourſe with *Lincolnſhire* rams, and your lambs to be (without an exception) of the true *Dorſetſhire* mold, &c. as to expect the wooly-ear'd wheat, &c. to produce its like, when it received the farina fecundans of the *Herefordſhire* brown, &c.—But the innovation in the latter is not perceptible that year the intercourſe happens, but in their embrios; more than the ewes

are themſelves changed by ſuch an intercourſe, although you make no doubt but their lambs will.

HENCE it becomes every one that ſells corn for change, to be ſtrictly upon honour with the purchaſers, relative to the above circumſtances:—for you can no more tell from the look of grain whether the plant it is pregnant with, is genuine or mongrel, than you can by the look of a hen's egg, ſay whether the chick it contains is game or otherwiſe.* The conſequences that await ſuch innovations, *Agricola*, *viz.* ſhortneſs of the ears, ſmallneſs of the grain, a ſhort quantity of what an equal ſowing of genuine grain would have produced on the ſame premiſſes; and the neceſſity of buying in new ſeeds: Theſe are, I think, inconveniences of too great magnitude to need any further explanation to prevail on you or any rational man to eſchew them; and ſtill a further proof to thoſe that are convinced of an affinity ſubſiſting between the vegetable and animal kingdoms, that croſſing is, in every inſtance, detrimental to the owners, and derogatory to the works of the adorable Author of Nature.

Agric. THE inconveniences you have enumerated, Sir, I own do often obtain; and the validity of your theory is greatly aided by the remedy we have recourſe to; to wit, the change of ſeed, eſpecially when it proves of one ſort. But how that property was to be preſerved, or how it happened to deviate, until this evening, I confeſs I was ignorant.

Phil.

* THE Author is aware that this doctrine, from its novelty and the ſterility of common minds, may appear and be pronounced futile, notwithſtanding it is a fact he has proved by experiment. He therefore wiſhes ſuch will be pleaſed to try the experiment for their own ſatisfaction.

Phil. I DO not wiſh to extort confeſſion, *Agricola*, nor to upbraid any with their misfortunes; but I muſt uſe the plainneſs to tell you, that every loſs you have ſuſtained by not knowing the above particulars, is literally the bad effect of want of theory.——You will now, *Agricola*, only permit me to repeat briefly what has been ſaid relative to the choice, preſervation, and change of ſeeds of corn, and cloſe the ſubject and the converſation.

FIRST, then, it has been ſhewn, that they ſhould be the deſcendents of healthy parents. Secondly, that they be well ripened, and properly preſerved, until ſown. Thirdly, that the ſoil be of a proper tone between moiſt and dry, when they are ſown; and that the weather be mild and freſh. Fourthly, that they be depoſited at a proper depth, diſtance, &c. and the mould in good heart, and ſufficiently pulveriſed. Fifthly, that the land be ſufficiently drained to prevent ſtagnant water. Sixthly, that if the land be caſt up by froſt, &c. that it be rolled in dry, freſh weather, with an inſtrument of ſuch ſize as will effectually re-eſtabliſh that degree of fixity which the plants and ſoil require to aid their joint efforts. Seventhly, if the leaves of winter corn, by the ſeverity of the weather, &c. are become withered,—that thoſe withered parts be amputated by being fed down with ſheep in dry freſh weather, before the ſtalk riſes; and that great care be taken they are not too near eat. Eighthly, that they be bright, plump, and without the leaſt offenſive odour; and at leaſt come up to the weight above ſpecified. Ninthly, that when ſteeps are neceſſary, that they conſiſt only of fair water, (or ſalt water, where it can be had) and quick lime, as above directed. And finally, that the

utmoſt care be taken in the flowering ſeaſon to prevent all grain of the ſame denomination, but of different ſpecies, having intercourſe.

AND now, *Agricola*, if there is any thing in that automaton* you hold up, that you would wiſh me to obſerve, I am at leiſure;—or, if you pleaſe, we'll adjourn to the other apartment, and there exhibit before *Soror* and *Argentatus*,—a gentlewoman who is not to you, I ſuppoſe, the moſt indifferent in all the world.

CON-

* AGRICOLA having often looked on his watch during the converſation, and holding it now in his hand, (a prank exceedingly impertinent, though practiſed by many even at church) occaſions this piece of raillery, in order to put *Agricola* upon his behaviour.

CONVERSATION XII.

PHILOSOPHUS.

I HAD no idea, *Agricola*, you were ſo excellent at a *téte-à-téte*, as I heard you laſt night, after we adjourned; but beſides wine, there is another ingredient which inſpires, I am convinced. Permit me, however, to thank you for ſo jovial an evening; and alſo, in return, to enter upon a ſubject for this evening's converſation, which I think will, in ſome meaſure, pleaſe you; *viz.* the theory of cultivating graſſes, the management of their ſeeds, and their other peculiarities, &c.

Agric. YOU leave me but few things to aſk for, Sir; but I own I have been oftener than once for requeſting that ſubject.

Phil. VARIOUS, and yet inimitably perfect and effectual are the methods, *Agricola*, the Author of Nature has appointed for the reproduction of graſſes and herbaceous plants!—Many, (indeed all that belong to this ſubject) like the corn genus, ſhoot up ſtalks which bear an ear or head; in which ear are contained, if the ſoil, climate, and other circumſtances be favourable, once or oftener every year, ſeeds, that when ſown, (or even as they ſhed themſelves) produce plants ſimilar to thoſe that ſent them forth. And moreover, as the beaſts of the field were to ſubſiſt daily on ſuch herbage, and conſequently would injure that mode of reproduction,—they all, or moſt of them, (particularly the *perennials*) *polypus*-like, are capable of reproducing from

from cuttings; and both deciduous and ever-greens, as well as them, by having part of their roots cut in ſpring, &c. acquire greater ſtrength thereby; as from the ſtumps iſſue out innumerable fibres, which uſually take the beſt directions, and extend to incredible diſtances, if not interrupted, in ſearch of food.*

THE GOD of Nature, *Agricola*, having thus effectually provided againſt the annihilation of graſſes and plants, and made it our intereſt to cultivate their growth,—we ſtand juſtified, even in the ſight of that adorable Being, in devoting part of our time to thoſe purſuits.

AND I believe we may venture, without a perhaps, to aſſert, that duly attending to their organization, and other peculiarities,—the efforts of Nature, the ſucceſſes ſhe has, and defeats ſhe ſuffers, and their cauſes, will be the moſt pertinent mode of inveſtigating a direct theory of the management of thoſe ſubjects, and therefore ſhall proceed in that order.

WE have already ſeen, (when treating of the corn tribe) *Agricola*, that there is a viſible affinity between the organization of animals and vegetables (ſenſation and motion being almoſt the only diſtinguiſhing characteriſtic of the one from the other) and that the ſoil is to the latter, what the ſtomach and inteſtines are to the former; for the abſorbent veſſels or roots, by being properly diſperſed and covered in the contiguous mould or

* THIS circumſtance, which is authenticated by obſervation as well as theory, vindicates the practice of harrowing wheat in the ſpring; and alſo the harrowing or ſcarifying of paſture ground, eſpecially when the ſurface is in a few days buſhed over, and then rolled with a roller of ſuitable weight, to put the ſoil and roots into contact, &c.

or ſoil, extract from it the neceſſary ingredients of vegetation, in a manner ſimilar to the abſorption of the lacteal veſſels in the ſtomachs and inteſtines of animals.

Agric. I PERFECTLY remember what was ſaid on that occaſion, Sir; and remain diſſatisfied in nothing relative thereto, but the manner of extracting the food;—for the words *abſorb*, *abſorption*, *imbibe*, &c. give me no competent idea of the operation. As well might I content myſelf with being told, (as formerly believed) that the pump ſucked up water, as that the roots of plants, &c. ſuck up the nutritious juices of the earth.

Phil. I AM glad, *Agricola*, I rallied you a little the other night, as it ſeems to have rouſed you out of that paſſive ſlumber you had fallen into. You have now, I own, given me a rub that has often, in my private hours, made me penſive; and even now, to anſwer you will be a taſk I dare not pretend to ſay I can perform, and uphold it conſonant to the received opinion. However, as you ſeem exceedingly anxious under this difficulty, I ſhall do my beſt to relieve you; but mind, I only call it an hypotheſis, what I ſhall deliver on this head.

FIRST, then, *Agricola*, in order to give you an idea of the hypotheſis which I formed to ſatisfy myſelf relative to that enquiry, it will be proper to inform you, that I firſt ſuppoſed there was contained in all bodies, though ordinarily inviſible, an element or firſt principle, capable of an infinite degree of expanſion by heat, and contraction by cold. Secondly, that this principle, as long as bodies continued in a ſtate of heat conſiſtent with their vegetation, was not only the bond of union in their parts, but alſo had an attracting or accumulating miſſion. Thirdly, that this principle, when bodies by any means acquire

a degree of heat which materially alters the expanſion of their ſolids, and ſo continues to do, that ſuch expanſion becomes a repulſive power, and diſſipates them. Fourthly, that in thoſe caſes, if furniſhed with a conductor, it conveys to the next vegetating bodies ſuch atoms or original materials as it is clothed with;—which propoſition, I flattered myſelf, received ſome confirmation from the great ſucceſs of vegetation near great towns. And this I thought might, upon this principle, be facilitated ſeveral ways, viz. by the vehicle fraught with thoſe diſſipated particles entering the leaves, &c. of the plants; or by its penetrating the ſoil, which is rather to be conſidered as a conductor than employer of this vehicle or accumulating principle, and entering the roots, which (I am inclined to think) contain a favourite conductor; and by the diſſipated particles of bodies, which were uſed as manures, being conveyed to the roots by ſimilar means.

AND upon this principle of tranſudation, *Agricola*, did I conclude the bodies of animals were ſupplied:—the lacteals in their ſtomachs and inteſtines being alſo furniſhed with a favourite conductor; after which it enters the blood, where it muſt receive a ſtill greater degree of expanſion; by which means it probably becomes uſeful in making the violent motion of the heart, and in conveying off (by perſpiration, or ſome ſuch means) certain diſſipated particles, that might prove injurious to the body, &c. And for as much as it (by being further expanded by the heat of the blood in animals) may thereby become of peculiar uſe,—ſo it may be conceived to become alſo peculiarly uſeful in plants, when it arrives to thoſe parts which receive the heat of the ſun, &c.

IN ſhort, *Agricola*, I concluded that this principle was the cauſe, either directly or indirectly, of all capillary motion or abſorption, both in animate and inaminate nature; and that therefore whatever means contributed to accumulate this principle, and render it active, ought to be attended to with the utmoſt diligence, when vegetation is the object of our purſuit.

Agric. BUT have you not a name for this neceſſary principle, Sir?

Phil. YES, *Agricola*, I am, for my own part, pretty well convinced, that it is that ſpecies of fire diſtinguiſhed in the philoſophic world by the epithet *Electricity*; and have made ſeveral experiments that corroborate the opinion, ſome of which I ſhall now relate to you.

MY firſt trial, after I conjectured electricity to be the efficient cauſe of capillary motion, evaporation, &c. *Agricola*, was to try whether (according to the aſſertion of certain electricians*) a veſſel of water would be ſooner emptied by a number of vegetable ſyphons when electrified, than it would be emptied by the ſame number of ſyphons when not electrified:—which aſſertion I found to anſwer; and that the ſmaller the pores of the ſyphons were, and the greater quantity of electricity the machine emitted, the ſooner the veſſel was emptied, *cæteris paribus*.

I LIKEWISE found, agreeable to the aſſertions of thoſe gentlemen, that electricity facilitated evaporation, particularly when the fluid was heated.†

* THE Abbe *Nollet*, &c.

† THE hot ſteam, when the machine is worked regularly, aſcends in a ſpiral direction, forming, in miniature, ſuch whirlwinds, as in times of great drought ſcrew up duſt, &c. from the roads.

AND alſo that animal and vegetable juices, and the tubes or lacteals they flow in, were excellent conductors of electricity :‡ —and that electricity aſſiſted digeſtion in the animal ſtomach, and the growth of plants, in the ſoil.§ The reſult of theſe experiments encouraged me greatly in the faith of my hypotheſis: But what above every other occurrence confirmed me in it, was, that by experiments I found all the elements are primarily electrical,—and conſequently attract that active property ;—and that they do not conduct or tranſmit it to bodies, without a peculiar excitation. For inſtance, oil refuſes to conduct electricity, until it is rendered miſcible with water, &c. and until it is in that ſtate, it is no way friendly to vegetation. Earth, until it is moiſtened, alſo refuſes to conduct electricity; nor doth any plant vegetate therein, until it is in that ſtate.— Water (*i. e.* the merely aqueous parts of it) doth not conduct electricity ſo well, as when mixed with the other elements: nor is it ſo ſerviceable to vegetation when pure, as when mixed. Air, until moiſtened or heated, is alſo a very imperfect conductor of electricity. And the effect of froſty air on vegetables, is ſufficient to convince every body that it is unfriendly to vegetation in a dry ſtate. Nitrous ſalt is alſo a bad conductor of electricity, unmixed with other ſubſtances; and in that ſtate it is found to be detrimental to vegetation, as Dr *Home* and others have ſhewn.

BESIDES theſe diſcoveries, *Agricola*, I alſo found that all the ſubſtances I have denominated inſtrumental manures, *viz.* lime, both

‡ MR *Kennerſley*' Experiments, &c. alſo prove this.

§ The Abbe *Nollet*, and Mr *Jallabert*'s experiments alſo prove this fact.

both in ſtone and powder, aſhes of all kinds, marles, &c. &c. are ſeparately and without ſome peculiar excitation, all of them bad conductors of electricity.

FROM theſe reſults, *Agricola*, I felt much ſatisfaction; for as even the elements themſelves ſeparately retain this principle, I could no longer doubt of its univerſality. And as when ſuch a compound of the elements is made, as renders them ſuitable to the great work of vegetation, and are excited by the heat of the ſun, &c. they become ſubſervient to its miſſion; as is evident from their then becoming conductors of it; and alſo of their being moved by it:—of which the excellence of animal and vegetable juices, &c. as conductors, the facility of capillary motion, and the vigorous growth of plants when electrified, afford ample teſtimony.

Agric. I READILY admit, Sir, that the principle you mention forwards capillary motion, aſſiſts the growth of vegetables, &c. when thrown in by a machine; but the great difficulty with me is, whether that operation, although it doth aſſiſt in thoſe caſes, when ſo handled, may not yet be compared to placing a pump by the ſide of a ſpring of water, in order to fill a reſervoir in a leſs ſpace of time,—which it will undoubtedly do. But, notwithſtanding that, Sir, I know you will not give it as your opinion, that it is performed by the ſame cauſe.

Phil. I THANK you for ſuggeſting your doubts, *Agricola*; and ſhall do all I can to reconcile them. Firſt, then, you will (I think) admit, that although a pump and a ſpring of water ſeem to operate from different cauſes, that there are many caſes wherein we aſſiſt Nature in her own way by machinery: —For inſtance, does not the bellows do the ſame thing to the

fire, that the air in the apartment does?—although, like the electrical machine, they do it to greater effect in a given time.

INDEED your own compariſon, *Agricola*, notwithſtanding you have put it very ingenioufly to apologize for your doubts, when fairly conſidered, does not make againſt the hypotheſis:—for if the reſervoir of the ſpring had not been higher than the ſpring itſelf, (if ſuch ſpring was not ſupplied merely by capillaries) it is demonſtrable the water could not arrive at it:—and therefore Nature had been employed in doing, although in an imperceptible manner, what the pump did viſibly. And if a ſpring is ſupplied by capillaries, Nature's agents, probably the very agent or principle I have mentioned, completes the work. For upon no other principle can capillary motion be accounted for, but that of attraction, viz. that the ſides of the tubes attract the fluid or liquor the tube is immerſed in, with greater force than the particles of the fluid attract each other. I will alſo requeſt you to obſerve, *Agricola*, that by experiment I have found, that capillary tubes made of electrics, *i. e.* of glaſs, ſealing-wax, &c. *cæteris paribus*, upon ſimple emerſion, raiſe water, &c. higher than tubes made of non-electrics, ſuch as tin, lead, &c. But on being excited by a machine, the non-electric tubes tranſude as large quantities as the electric tubes:—a circumſtance which coincides unexceptionably with the preceding concluſions; and likewiſe affords at leaſt an aſſumptive teſtimony that this principle is attraction itſelf.

NOW as the primary elements themſelves, *Agricola*, ſeparately, as we have already mentioned, are electrics, and conſequently bad conductors of it; yet when blended together, and excited by the heat of the ſun, or by any inteſtine motion which occaſions heat, they become excellent conductors of it, as we have alſo formerly mentioned.

WE

WE may infer, that the animal ſtomach and ſoil being receptacles for thoſe elements, and in which, when they perform their offices to good purpoſe, there is a fermentation, are natural electrical machines,—if I may riſk ſo novel an expreſſion. Conſequently, to enable them to execute their function properly, it is as neceſſary they be duly proportioned to their uſe, kept clean, fully laboured, and ſupplied with the elementary particles, as thoſe machines. But I will throw this matter into a more intimate compariſon, if your time will permit, *Agricola*.

Agric. MY time and inclination do both accord, Sir; otherwiſe I ſhould freely mention it:—for I well remember you premiſed in the earlieſt part of theſe converſations, that no unneceſſary ceremony or reſtraint was to be uſed on either ſide.

Phil. I am glad, *Agricola*, you attend to theſe preliminaries; for philoſophers are often exceedingly remiſs in point of urbanity.

Agric. PERMIT me to give it as my unfeigned opinion, Sir, that when any deficiency of that nature militates againſt them, mankind ought to aſcribe it to an abſtraction of thought, not want of civility.

Phil. IT would be amiſs not to allow you to treat us civilly:—but to proceed in the compariſon I propoſed. Know then, that the principal member in every electrical machine (whatever conſtruction it is of) is the field for excitation; uſually a globe, cylinder, or plate of glaſs, &c. This member I compare to the animal

ſtomach

ſtomach and victuals, and elementary particles and the ſoil. The two latter receiving their degree of excitation from the external and internal heat that accompany them; and the former from the friction of the rubber and circumambient matter.* And the excitation in all thoſe ſubjects, I believe, will be acknowledged to be performed to the greateſt advantage, when done in a gradual and regular manner. It is clearly ſo in the machine, as you may obſerve, *Agricola*.—See when I turn the machine regular, what large ſparks I draw from the conductor:—I now give it an irregular jerking motion.—See now, *Agricola*, what faint ſparks meet my knuckle?

Agric. THAT regular excitation has the greateſt effects on the machine (from what I now behold) I have received complete conviction.

Phil. AND I dare ſay there is not a phyſician in the univerſe, endowed with common ſenſe, that will not alſo aver, that a gradual and regular heat in the ſtomach is moſt friendly to digeſtion.

Agric. AND the great ſucceſs I have conſtantly obſerved which attends vegetation, when we have a moderate and regular degree of heat, compared with its languor in an extreme either of cold or heat, gives me a favourable opinion of this doctrine, I own, Sir:—but ſtill I am at loſs to comprehend any affinity between glaſs, ſoil, victuals, &c.

Phil. O, THERE lies the rub, I find!—However, do but attend to the following particulars, and that difficulty, I flatter myſelf, will be removed. FIRST

* The heat of the ſtomach of many animals is heightened by the coats of their ſtomachs, particularly thoſe that have more than one ſtomach, and moſt of the feathered tribe.

FIRST then, *Agricola*, recollect, that it has been premiſed, that, ſeparately, the primary particles of matter are violent attractors of electricity; but on being blended together, they become conductors of it:—now as glaſs is nearly, if not altogether homogeneous, (that is, of one nature as to its conſtituent particles*) it is conſequently the propereſt material for collecting that principle; and ſo indeed it is found by electricians. For as ſoon as the globe or cylinder, &c. is put in contact with the rubber, which is a heterogeneous or mixed body, and a proper motion communicated to it, the electrical fire is accumulated in ſuch quantities, that in the dark the glaſs becomes luminous, as far as the rubber is in contact with it.

Agric. THEN, Sir, if the animal ſtomach, &c. be affected in the ſame way, while digeſtion is going on, our ſtomachs may be ſaid to be frequently on fire.

Phil. THERE is no ſuch thing as giving ocular demonſtration of that, my good friend; but from the quantity of liquor your neighbour *Tadpole* and others ſwallow on a market-day, one would be perſuaded it is ſo.†

Agric. TRULY, Sir, I was not in jeſt.

Phil. NOR am I, *Agricola*. But do not be uneaſy;—I ſhall proceed. I had ſaid the glaſs on being put in motion, and in contact with the bruſh or rubber, becomes luminous:—this,

Agricola,

* GLASS conſiſts chiefly of vegetable ſalt; for by the faculty of the intenſe heat employed in making it, the heterogeneous particles are ſeparated.

† AGRICOLA's breaking in very abruptly, (a piece of behaviour exceedingly reprehenſible) occaſions this reply.

Agricola, you ſhall be witneſs to; for by putting that ſcene between the candles and the machine,we can make the room dark enough for the experiment—There it is done—You ſee, on two or three revolutions of the glaſs, *Agricola*, the phænomenon takes place.

Agric. IT does indeed.

Phil. BUT obſerve, *Agricola*, how this accumulated fire is drawn off, when I preſent this piece of metal ſuſpended on ſilken ſtrings to it, and let the chain at the further end of it drop on the table.

Agric. SURPRISING! how the fire gathers about the points of the wires ſtuck in the end of it, Sir; and is really flaſhing from link to link of the chain, at the other end of the piece of metal. But why do you give the piece of metal ſuch an offenſive appearance, by ſticking thoſe pointed wires at the end of it, Sir?—Is not that merely a whim of the maker?

Phil. THOSE points, *Agricola*, are as neceſſary to collect and carry off the fire from the glaſs, as the roots of plants are to carry off the nutritious juices of the ſoil; or the lacteals in the ſtomachs and inteſtines of animals, are to carry off the nutritive contents of the aliment. And let me tell you further, *Agricola*, the ſimilarity is ſo great, that the finer thoſe points are, the better they do their work, which is exactly the caſe with the roots of plants, &c.——What I have yet to advance on this ſubject, muſt be deferred 'till the next time you favour me with your company, *Agricola*; ſo for the preſent we'll adjourn to another apartment, and realize ſome of thoſe ſpeculations.

CON-

CONVERSATION XIII.

PHILOSOPHUS.

GLAD to ſee you, *Agricola*; for as you were ſo much later than uſual in coming, and as I have ever found you civil enough to forward a juſt apology, when you could not make good an appointment, I begun to fear ſomething amiſs had happened.

Agric. I HAVE been from home, Sir, and unexpectedly detained beyond my uſual time; otherwiſe ſhould have attended, or ſent to appriſe you.

Phil. MIGHTY well, *Agricola*; and now you are come, I ſhall not interrupt our ſubject any farther at this time, but proceed.—Beſides the affinity which ſubſiſts between the points of the conductor of an electrical machine, and the roots of plants, *Agricola*, (as mentioned at the concluſion of our laſt converſation) there is alſo great ſimilarity between thoſe parts of the machine, and the food of plants and animals. For as no electrician can tranſude electricity, when the bruſh or rubber of his machine is inſulated; neither can any means ſupply the lacteals with chyle, unleſs food be brought into contact with them;—and even then, unleſs the powers of digeſtion duly exerciſe their functions, the lacteals, like the conductor of the machine, when the other members of it are not at work, can have nothing to tranſmit.

AND ſimilar to theſe is your caſe, *Agricola*, with reſpect to ſuccouring a crop; for unleſs the ſoil is ſtocked with primary atoms, which eſſential manures contain, and inſtrumental manures acquire, the crop will languiſh and die. And after all, it is to no avail if the ſoil has not, together with the manures in it, a proper degree of warmth; which warmth, as I have before hinted, I am for my own part fully perſuaded, gives vigour to the tranſuding principle; and the atoms which are diſengaged, are by it then either driven or carried along its favourite avenues to the proper receptacles for vegetation.

WITH reſpect to the uſefulneſs of a proper degree of warmth, *Agricola*, I need only call your attention to the dormant ſtate all Nature is in, when frozen. In that ſtate, ſuppoſe the ſoil were nine-tenths of it the richeſt manure in the univerſe, there is not the ſmalleſt effort to vegetation:*—and with reſpect to animal digeſtion and nouriſhment, were it not for the warmth in the ſtomach, the victuals would ſuccour the body as much by being put into the pocket, as by being put into it.

UPON the whole, *Agricola*, and to conclude this digreſſion, (which, although delivered very laconically, has rather too long prevented

* AND this, perhaps, is the reaſon that the air in froſty weather is ſo replete with electricity, as then neither vegetation nor putrefaction are going on. And upon the ſame principle it may be expected, that in the ſeaſon when vegetation is moſt vigorous, the electricity near the ſurface of the earth will be rendered very rare, while at the ſame time the electricity with which the clouds in the higher regions of the atmoſphere are charged, may be very denſe;—hence, to reſtore the equilibrium, we have thunder. Whoever pleaſes to attend to this theory, may, I doubt not, be able to predict a thunder ſtorm or rain.—I do not mean they can tell the day or the hour it will happen; but from long obſervation I am convinced, there is more than mere conjecture in this matter.

prevented the diſcuſſion of the theory of graſſes) I again give it you as my real opinion, that this ſubtil principle is a conſtant attendant on bodies when they are diſſolving, and alſo when they are in a growing ſtate; carrying or driving off the atoms in the former, and carrying or driving atoms to them in the latter condition. Which aſſertion, I preſume, is ſufficiently corroborated by the advantage which accrues to vegetation by being electrified; and by the bad effects that attend electrifying bodies that are under even diſtant ſymptoms of mortification.

Agric. THESE, Sir, are things I own I never had any ſuch idea of before; but how am I, as a huſbandman, to reap advantage from them?—for ſure there is not a poſſibility of electrifying all our land!

Phil. As to electrifying all your land by machines, there is not a poſſibility of doing it, *Agricola*; but upon the idea that I have more than once ſuggeſted, namely, that this eſſential principle is on vegetating and diſſolving bodies a voluntary and certain attendant,—I think we may give our lands the advantage of it, *viz.* by laying them dry, dreſſing with eſſential manures, or even inſtrumental manures, and putting them under ſuch culture as excites that kindly warmth I have ſo often mentioned, that ought to militate to make this principle act with vigour; and finally, to ſtock them in the proper ſeaſon with healthy plants, and take care that nothing mix therewith to rob them of the air and nutriment. And now, *Agricola*, to your ſatisfaction, I doubt not, you ſee how exactly the beſt practice in huſbandry and our theory do agree.

Agric. TRULY, Sir, the fameneſs in the concluſions makes me inexpreſſibly happy; but withal ſuffer me to aſſure you, I do with the utmoſt ſincerity acknowledge, that I think every huſbandman muſt reap exceedingly more ſatisfaction, and often more gain in the proſecution of his profeſſion, when he attends to theory, than practice alone; as in the latter, miſapprehenſion, and conſequently miſrepreſentation, muſt often (like the traveller that depends upon hearſay and accidental directions for his road over untrodden *Alps*) be much embarraſſed, always in dread, and often diſappointed.

Phil. YES, *Agricola*, there are but too many chances for diſappointment under a hearſay or random huſbandry; and a diſappointment of this ſort does not at once terminate; for not knowing whence it proceeds, it is odds againſt us, when we attempt to correct it, but we get farther wrong; and therefore may be many years in finding out the true cauſe, and probably, in many caſes never accompliſh a perfect inveſtigation thereof.—It may ſeem indeed by the above general directions, that the particulars are ſo few, that they cannot be miſtaken; but let us never forget, *Agricola*, that the contrariety of ſeaſons, the impoſſibility of commanding in every caſe the beſt manures, in proper quantities, and the ruinous ſtate that many eſtates are in by bad management,—and we cannot heſitate one moment to conclude, that nothing leſs than a full knowledge of the laws and properties of Nature can direct to the beſt ſucceedaneum when we have any of theſe impediments to combat.

MUCH might yet be ſaid on this head, *Agricola*; but as you have been ſtrictly attentive to the ſubject, I make no doubt but your own induſtry, and the peruſal of theſe papers will enlarge your

your ideas of it to a competent degree, ſo ſhall return to the culture of graſſes.

IN a former converſation, *Agricola*, I have mentioned the moſt obvious and general methods which Nature offers for the reproduction of graſſes and herbacious plants;—I ſhall in the next place conſider the means moſt likely to preſerve their ſeeds for future uſe; the diſcuſſion of which will not much detain ſome other ſubject; for the beſt method that either theory or practice has deviſed, is to let them be fully ripened, and then to treat them in the ſame manner we have preſcribed for the preſervation of the ſeeds of wheat, *&c.* But as the hay of ſuch graſſes as ſtand to ripen the ſeeds ſufficiently, becomes ſtickey, and in a great meaſure devoid of thoſe nutritive particles which the graſſes contain when in flower,—I adviſe you, if it is for the ſake of hay you ſave your graſs-field, to mow it in the decline of the flower, if the ſeaſon be fine; or if when the flower is in prime, the ſeaſon is fine, cut it then; for it is more beneficial, as well as leſs troubleſome and perplexing, to take them a little early, and have fine weather to make them, than to let ſuch an opportunity ſlip, by poſt-poning the harveſt for the ſake of having them a little harder; for what they fall ſhort in quantity, the aftermath or fog will more than repay. I ſay more than repay, *Agricola*; for graſſes ſhoot with greater vigour when cut before their ſeeds are perfected, than afterwards. Nor do I think this circumſtance takes its riſe entirely from the advance of ſeaſon, but from their natural propenſity to reproduce in conjunction therewith; ſo that thoſe who let graſſes (clover in particular) grow hard before cut, becauſe the ſeaſon is early, always loſe in the after-maths:—and a loſs in the aftermath of natural graſſes, is a mighty detriment

to

to the land; becauſe when the aftermath is deep before it is fed down, the ground of it is too earthy to be liked by the ſtock, and is therefore left, and becomes a dreſſing to the land, as well as ſhelter to the roots in winter.

AND graſs, when cut to make it into the beſt hay, *Agricola*, ought to be kept moving from ſun-riſing until ſun-ſet while graſs, if the weather is dry, by which means it is cured or becomes dry in the leaſt time poſſible, which makes it retain more of its eſſential juices than when long expoſed to the ſun and air; they being thereby diſſipated and carried off, perhaps by the principle you have ſo lately heard ſo much of; and in the night ſeaſon to ſecure it from rain or even dews, it ought to be thrown into cocks, the ſize of which are to be regulated by its dryneſs, or approach to hay; and when it has acquired that degree of dryneſs, in order to prevent mow-burning, it is neceſſary to increaſe the ſize of the cocks conſiderably; and if the ſeaſon is catching, to ſtrew a piece of ſtraw or coarſe hay over the tops of them, by which means they may ſtand a few days in the field after they are hay, which will prevent not only the hazard of being conſumed by firing, but preſerve the fodder ſweet and nutritive.

Agric. IT is the opinion, Sir, of many huſbandmen, that hay is the better for being ſtacked green, and alſo that it is the better for being mow-burnt.

Phil. I KNOW ſuch opinion does obtain, *Agricola*; and that the practice is commended by ſome authors:—but I beg leave to differ from that opinion, and have good reaſons for ſo doing, which are as follow:—Firſt, becauſe when graſs is laid in large heaps before the ſoft juices are evaporated, it is clear (from a fundamental principle in chymiſtry) that fermentation muſt

muſt enſue. And it is alſo an uncontroverted fact, that Nature proceeds from the beginning of fermentation, in ſubjects of this denomination, directly in a continued ſeries to putrefaction, if there be a ſufficient quantity of water contained in the maſs, or put to it, and if not prevented by a deprivation of air :— and this is the reaſon why hay-ſtacks that are heated rot ſooner when they get rain, than cold ſtacks do.

Agric. BUT we take care, Sir, to cover our ſtacks ſoon, and ſo prevent wet ſinking into them.

Phil. IT is well you do, *Agricola*, otherwiſe you would complete this voluntary proceſs of Nature; and I perceive, altho' in moſt caſes you eſcape both fire and total rottenneſs, yet in no caſe that can be denominated mow-burning, do you eſcape a partial putrefaction; for mouldineſs amounts to that.

AND as even putrid air is deſtructive to animal nature, (as I have before hinted, *p.* 121) putrid food ought more ſcrupulouſly to be avoided; as all hands own it directly attacks the parts it comes in contact with, as a ferment or leaven; and if exceedingly ſtrong, will greatly injure the healthieſt ſubject; and even when languid will have bad effects on weak ſubjects. And this, *Agricola*, I venture to ſay, is the reaſon that cattle that have tender bowels, and are ſubject to looſeneſs, turn feveriſh and die when turned to feed on mow-burnt hay;—and it probably is alſo the reaſon that every creature that eats it, drinks ſuch large quantities of water;—a method Nature points out to abate the inteſtine heat, and carry off by copious diſcharges of urine, &c. the pernicious dregs of this offenſive matter; which evacuations, together with conſtant uſage, as that becomes a ſecond nature, may prevent ſtrong ſubjects from

appearing

appearing much injured by it, unleſs they meet with ſevere travel or hard labour, and then drinking ſuch large quantities of cold water as can allay the heat of their ſtomachs and bowels, often occaſions gripes, inflammations in the bowels, and even death itſelf. But when this is the caſe, the ſevere exerciſe is commonly ſaid to have occaſioned it; and thus, *Agricola*, without ſo much as ſuſpecting the cauſe, many men (hoſt-men in particular) have burnt their fingers by mow-burning their hay.

Now, *Agricola*, if this is the caſe, (as I am much inclined to think it is, and deſire you may remark in future whether cattle and horſes that are fed with mow-burnt hay, do not more frequently ſuffer than thoſe that are fed with ſweet hay, all other things being equal) I ſhould therefore be glad to know from you or any other perſon, what there is in view by mow-burning hay, to tempt men to run ſuch riſk, or any riſk whatever? As it is againſt all the eſtabliſhed laws of chemiſtry to expect its quantity will increaſe by heat; and it is equally repugnant thereto to imagine any virtues can be added thereby.—For as I have often told you, and as you may inveſtigate by experiment, all vegetable ſubſtances loſe even by fermentation ſome of their more ſubtile parts, particularly their ſalts and oils; and putrefaction (which after a very low degree of heat takes place) muſt occaſion ſtill far greater quantities* of the nutritive parts

* BESIDES the inconveniences above enumerated, the diſſolution (by the heat) of poiſonous weeds, that eſcape the moſt vigilant huſbandman's eye, ſuch as the dwarf hemlock, henbane, crowfoot, dropwort, &c. which cattle by inſtinct will refuſe to eat, when laid in their ſtall; as thoſe plants are ſtrong poiſons while entire, it is beyond a doubt the very fumes of them (which for certain impregnate thoſe parts of the ſtack contiguous to them, when the heat is great) are alſo hurtful to animal nature, though they may not amount to an inſtantaneous poiſon.

parts to fly off. There cannot therefore be any other motive to ſuch a practice, but the ſaving in labour; which put in the ſcale againſt the many diſadvantages which have been ſet forth, and very probably obtain, the perſon who purſues ſuch a courſe, is gleaning a ſtraw, and throwing away whole bundles.

Agric. IT is very probable the anxiety that huſbandmen are under in the hay-harveſt ſeaſon, leſt bad weather ſhould come, has introduced this practice; and the inconveniences that attend it lying ſomewhat remote, (indeed ſo much ſo, that the bad effects, as you have obſerved, are aſcribed to other cauſes) has prevented its being aboliſhed; however, for my part, I am determined to abandon it.

Phil. PROBABLY theſe are the reaſons, *Agricola*; and I am at the greateſt diſtance from thinking that men of candour and good ſenſe, ſhould they take the practice and its inconveniences into conſideration, can perſiſt in it.

To thoſe, *Agricola*, who delight in huſbandry, what has been ſaid on this head I preſume will be ſufficient:—to thoſe who do not, there is not a poſſibility even of gueſſing what is ſufficient; nor would it be either entertaining or inſtructive inſtead of principles, to preſent you with long details on the mere practical branches, ſuch as mowing, raking, leading, ſtacking, &c. &c. that in general being perfectly well underſtood; I ſhall therefore, if agreeable to you, explain my thoughts on the preparation of ſoils of different kinds, and in different ſituations, for graſſes of various ſorts and for various purpoſes.

Agric. EXCEEDINGLY agreeable, Sir.

Phil. FIRST, then, *Agricola*, we will ſuppoſe ourſelves engaged to reclaim a piece of land which has been tired with growing corn, left poor, and full of weeds; the ſoil bad, of a northern aſpect, and ſpringy. And in our management of this we will ſuppoſe ourſelves free from any reſtraint in our improvement with reſpect to fitting it peculiarly to any particular farm:—what we ſhall attempt is merely the making of it grow graſs, in order to make it of ſome uſe to the occupier; and by continuing it under graſs ſome time, recover it to the proprietor.

THE firſt thing, *Agricola*, in this caſe that I would do, would be to cut open the ſprings and drain them into the furrows;—for I cannot but ſuppoſe ſuch land to be in round ridges, and having a deſcent. The readineſs of the materials for filling drains, will no doubt determine the ſort of drain, although ſtones are the beſt when they can be had at a tolerable expence; I ſhall not therefore trouble you with particulars on that operation, only let it be done effectually; for until the redundant water is drained off, it is as impoſſible to make the beſt graſſes grow in it, as to reſtore the tone of the debilitated parts of the viſcera in a dropſical caſe, until the waters are diſcharged.

HAVING completed the drains, and picked the field with ſheep or other cattle in dry weather, as clean as poſſible, I ſhould ridge it up very thin before winter, and ſo let it lie until April or May; for ſuch land has not pabulum in it to make even weeds grow rapidly; about that time, if the land and weather be dry, ſhould harrow it well, and employ people to pick up the weeds, make them into heaps, and burn them on the land; and as ſoon as ſcaled, provided the weather keep dry,

dry, I would plow back the furrows, or rather mold, that was ridged up before winter, taking care to go a little deeper with the plough than at that ſeaſon; and if the weather ſtill continued dry, ſhould harrow it again ſeverely, and employ the people to pick up all the weeds they could find after frequent harrowings; which weeds, as before directed, ought to be burnt, and ſpread on the land:—after which (ſtill ſuppoſing the weather dry) I ſhould ſpread very carefully, a ſmall quantity of quick-lime upon it, if to be had; if not, a little of ſome of the other inſtrumental manures, and harrow it again; and as a means to prevent it from turning mirey, (as it will do, ſhould heavy rains come) while it lies with a harrowed ſurface, I ſhould give it a double or more (if it did not become very compact with a ſingle) with a heavy roller; and water furrow it, even on the tops of the ridges, to prevent water lodging upon it. And as other buſineſs might by this time require attention, ſhould let it lie rolled for a month at leaſt, in which time, if any marks of fermentation appear upon it, ſuch as the rolled face cracking, or the mold turning looſe, &c. ſhould conclude the roots of the weeds, &c. that remained in the land were approaching to a diſſolution, and conſequently to food for plants; for as I have often told you, *Agricola*, fermentation is the harbinger of putrefaction, and putrefaction is the ſupply of new modifications.

SUCH appearances help to regulate the future treatment; as a leſs quantity of manure will ſerve when they militate, than when they do not. However, at any rate, if the ſoil and condition be what we have above ſuppoſed, there will be occaſion for manure; and black dung, ſtreet ſweepings, the drainage and muck of ſlaughter-houſes, ſwine dung, old tan, pigeon dung,

poultry dung, in proper quantity*, will anſwer the end.—There are alſo many other kinds of manure, *Agricola*, as you well know both by theory and practice, *viz.* rabbit dung, old linen rags, woollen ditto, urine, ſoot, ſea-weeds, ſea-ſhells, ſalt, &c. &c. moſt of which, or a compoſt of them, would do very well. But if they ſhould lie unhandy, I would uſe an artificial manure, perhaps little inferior to moſt of them, and what can be had almoſt in any corner of the nation, and may be prepared by the farmer's own hand, in the following manner:—*viz.* To three gallons of ſtrong lime water, put three gallons of train oil, which by ſtirring and beating will unite into a balſam-like ſubſtance; into this mixture ſtir as much dry burnt earth and ſea-ſalt (in the proportion of five-ſixths of the former to one of the latter) as renders the whole maſs an unctuous duſt. If this duſt is juſt ready when the graſs-ſeeds are to be ſown, (which I would incline to do in *Auguſt*) I would ſow it upon them, and harrow all in together, allowing the above quantity to each acre.§

Agric. I PRESUME you would plow the ground another time before you ſowed the ſeeds and manure, Sir?

I

* OF the firſt, about fifteen chaldron per acre; or of the ſecond, about the ſame quantity; or of the third, about ſeven chaldron per acre; or of the fourth, four chaldrons per acre; or of the fifth, twenty chaldrons per acre; or of the ſixth, one chaldron per acre; or of the ſeventh, one and a half chaldron per acre.

§ I HAVE by trial found this manure very ſucceſsful in promoting the growth of both graſs and corn; and as ſalt uſed in huſbandry is not charged with duty, and as train oil is the beſt as well as cheapeſt oil, and as burnt earth coſts little beſide labour; the above quantity (which is a good dreſſing for an acre of land) may be made for ten or eleven ſhillings. I know of no bad effect it can have on any land or crop;

Phil. I CERTAINLY would both harrow and plow it, *Agricola*; as we left it ſplit down and rolled. I would therefore (the weather being dry) harrow it well, and ridge it up again with the plow immediately; and as the tops of the ridges had been water-furrowed, by being now ridged up, they will become equally rounding in all their parts, the convenience of which I have ſhewn you before, and therefore need not again trouble you with it. I ſhould alſo harrow it after it was ridged up by the plow;—for although the furrows of this plowing ought to be thin and neatly laid, yet they will not be ſmooth enough for the ſeeds, unleſs they are pulveriſed with a fine harrow.

You are alſo to obſerve, *Agricola*, that I would purſue the ſame courſe in caſe any of the other manures had been uſed;—hence, as there is ſo much harrowing neceſſary when graſs ſeeds are ſown, it is exceedingly troubleſome as well as waſteful to uſe long manures.

Agric. I HAVE always found it ſo, I own, Sir; and therefore I think the artificial manure on that account is very convenient; nor do I fear but it will have good effects on land, whether cropped with graſs or corn.

Phil.

nor is there any thing diſagreeable attends making and ſowing it, except the ſmell; that, I own, many will wiſh to diſpenſe with. The turf or ſods that are intended for aſhes for this manure, ſhould only be burnt black, after which they ſhould be put through a fine riddle, and kept dry until uſed. Great care muſt be taken in mixing the aſhes with the oily matter;—this I have always done by making part of the aſhes into a dam, and putting the oil, &c. in it; then keep ſtirring round, and adding more aſhes, until the whole becomes dry and fit to be ſown by hand.

Phil. YOU need not fear it, *Agricola*; its conſtituent parts are not only themſelves food for plants; but when moved by warmth, very ſtrongly excite the active principle we have been ſo lately inveſtigating.—But I ſhall give you an eaſy experiment to prove its attractive quality when heated.—I take this ſheet of draft paper, *Agricola*, and rub it with the compoſt.

Agric. PRAY let me do it, Sir.

Phil. VERY well,—you ſhall do it, *Agricola*.

Agric. It is done, Sir;---bleſs me, how greaſy the paper is!

Phil. HOLD it to the fire, *Agricola*, and then bring it gently over that plate of fine ſaw-duſt, without touching it, and obſerve the effect.

Agric. ASTONISHING! the duſt flies to it, as duſt does to a plate hung to the conductor of an electrical machine.—And I think I perceive the reaſon why it does ſo:—the heat, I preſume, throws the oleagenous particles into a ferment; whence that active and ever conſtant attendant of diſſolution, ruſhes in, and moves thoſe light bodies with its atmoſphere.

Phil. YOUR ſolution, *Agricola*, is plauſible, and perhaps as juſt a one as can be given; but although your philoſophy affords me the utmoſt ſatisfaction, in order to return to our method of laying down the field, I ſhall wave all remarks at this time. I cannot, however, help telling you, that I had the firſt intimation of heated oiled paper attracting ſaw-duſt, from an ingenious

ingenious gentleman in the North of *Northumberland*, who ought to have the credit of the obſervation; but as I have not aſked his permiſſion, I am not at liberty to mention his name.

THE land having got the above preparation, *Agricola*, in order to attain and continue a ſward, due attention ought to be given to the kind of ſeeds we ſow it down with, and its future treatment. The perennials in courſe muſt therefore be our choice, and of them I eſteem none fitter for this ſituation and ſoil than Ray-graſs; becauſe its roots do not only continue many years alive, but it is both an early and a late graſs; and, provided it is mown before it completes its ſeeds, it is not more an impoveriſher than other perennials; and by being mown before the ſeeds are ripe, it ſoon ſends forth freſh leaves; hence a verdure immediately ariſes, and the unſightlineſs of the ſtalks, when they are become ſpiry and white, as well as the inconvenience of their preventing cattle eating to the bottom of the paſture, vaniſhes,

OF this valuable graſs, (the white Ray-graſs) I would ſow a buſhel and a half on an acre; and of white Dutch clover, and hop clover, each five pounds; and provided freſh hay-ſeeds, which grew on a ſimilar ſoil and ſituation can be had, I would alſo ſow three buſhels of them on each acre. If theſe cannot be had, ſow in lieu thereof four pounds of rib-graſs ſeeds to an acre. It is, I own, a great impoveriſher when it is allowed to ſeed; but as the field is to be mown to keep the ray-graſs in order, as the rib-graſs keeps pace with it, one remedy ſerves for all. And although the hay ariſing from ſuch an early mowing may be inconſiderable, experience has ſhewn it a juſt and imitable practice, and what ought to be done every year; after which the large roller and buſh harrow ought to be uſed, as well

well as in ſpring and autumn; as the former brings the ſoil and the roots of the graſſes into a more intimate contact; and the latter rubs the ruſt (if I may riſk the expreſſion) off the ſurface, and thereby gives the ſoil the benefit of the dews and other fructifying means, as well as eradicates moſs in ſome caſes, which is an univerſal ſpoiler.

BESIDES the rollings as above deſcribed, *Agricola*, the graſs-ſeeds when they are ſown, *viz.* the ſmall ſeeds well mixed at one ſowing, and the light ſeeds, *i. e.* the Ray-graſs and hay-ſeeds at another, (but on the ſame day) after they have been laid in by a fine harrow, I ſhould roll them with a light roller. And although I ſhould not water-furrow the ridges after the ſeeds were ſown, I would have the land worked to ſuch a ſlope, that it could not detain pools of water.

Agric. THERE is ſomething unuſual (and apparently a loſs) in this mode of ſowing down land, Sir; *viz.* not taking a crop of corn; and as I wiſh to have your ſentiments on every article of importance, I thought it beſt to mention this circumſtance before it eſcaped me.

Phil. ALL fair, *Agricola*;—but hark!----oho! old Time and our friends ſtill keep watch over us, I find;——there's warning for work of another nature, *Agricola*;—let's honour *Soror*'s invitation to ſupper, and at our next meeting what you have now propoſed ſhall be attended to.

CON-

CONVERSATION XIV.

AGRICOLA.

I AM ſooner than uſual to-night, I believe, Sir; but do not, on that account, deſire to engage you until it is altogether convenient.

Phil. NOT a bit too ſoon, *Agricola*; I am ready to give you my reaſons for omitting a crop of corn when I ſow off (with graſſes) ſuch land as we were treating of laſt night:—and they are briefly theſe. Firſt, by taking a crop of wheat, or even ſpring corn, it is evident, as two crops muſt require more food than one, that we give the land conſiderably more to do; and as the land is but juſt recovering from abſolute poverty, it is ſimilar to lending a needy man money to-day, and taking it from him to-morrow. Secondly, when we ſow graſs ſeeds with corn, if the crop of corn is good, moſt of the graſſes, for want of air and ſpace, loſe health,—indeed often die; and although the riches of the ſoil may fluſh thoſe that ſurvive this inconvenience after the corn is harveſted, whoever will carefully examine a field under ſuch predicament, will find them thin at bottom, the ſtalks very ſlim, and the roots few and collapſed; whereas when ſown in Auguſt, without corn, and rolled at convenient times, the roots are ſtrong, and extended; on which circumſtance, and ſaving it from winter feeding, depends both the profit and pleaſure of its future appearance and produce.

Agric. WINTER ſaving, I know by experience, is a good thing; the ſucceeding crops being always larger, the harveſt ſooner, and the aftermath deeper.

Phil. AND theſe advantages, *Agricola*, once introduced, revolve in courſe. But in the preſent, and every ſimilar caſe, *Agricola*, in order to reclaim the ſoil, I recommend holding it to paſture at firſt; and the ſtock I ſhould feed it down with (if particular circumſtances did not oblige me to another courſe) would be young cattle; and provided the field was let into ſufficient growth before the cattle were turned in, I think there would be no advantage in ſtinting it thin; for that gives too much choice; and the conſequence is waſte of graſs, and diſeaſe to all young, ruminating animals. But mind, I do not by this hint mean, that young cattle ſhould be pinched for graſs; what I intend to inculcate is, that they thrive as well, often better, when kept upon their legs, and their chops wagging four-fifths of the day, than when they lie half the day pained and panting for cud. And the reaſon why cattle are diſtreſſed in that particular capacity is, they cram the *rumen* or firſt ſtomach ſo inſtantaneouſly, that the whole maſs of crude aliments is ready at one inſtant to return to the mouth to be chewed; a matter impoſſible to be done, and muſt occaſion great uneaſineſs; whereas when the food is taken in gradually, it returns in its order without difficulty, and the creature has time to chew and fit it for digeſtion.*

Agric.

* WHEN the maſs happens to be ſoft clover, as that food begins to ferment immediately, the cud ſtops at once; whence the inconvenience advances ſo rapidly, that in a few minutes the lungs are unable to play, the conſequence is death, if vent is not given to the rarefied air in the paunch, &c.—The way therefore to prevent this

Agric. I BEG leave to mention a thought that has this moment ſtruck me.——It is perhaps a wild one, Sir, but I hope you will excuſe me if it ſhould really to you appear ſo.

Phil. Do not forget the preliminaries of our meeting, *Agricola*; and that the intention of philoſophy is to inveſtigate the ſecrets of nature, and reconcile men to diſappointment. In ſhort, *Agricola*, when we attain a new idea, (a circumſtance that rarely happens) it is manly to ratify it. Every man ought to revere and encourage the man that acquires new rational ideas; for although they ſhould not illuſtrate the matter at firſt alluded to, they may lead to ſomething far more excellent.—But, *Agricola*, what is it that has occurred to you?

Agric. I THINK, Sir, that too large a quantity of coarſe food taken into the ſtomachs of cattle when young, occaſions their being ſide-bellied when they grow up; for to get a very moderate quantity of nutriment from coarſe food, the belly muſt be loaded:—whereas a light belly-full of nutritive food

ſort of diſtreſs is, not to ſuffer cattle feeding on rank or wet clover while they are ſo exceedingly eager about it, (as they always are at firſt turning in) to go upon it hungry; nor at any rate to feed on it 'till they have eat half a bellyfull: and when taken off, to be put where there is no food, which will give place to the exerciſe of the cud. When cattle have got hoved with clover to a great degree, the only expedient to ſave life, is to thruſt a penknife into the paunch, making a ſmall inciſion between the lower end of the ribs and the navel; and after the inciſion is effectually made, which will be perceived by fetid air iſſuing out, put a long gooſe quill, open at each end, into it.—Next prick each kidney vein, and let the creature bleed freely, and at the ſame time inject large quantities of ſtrong fumes of brimſtone up the creature's fundament by a tobacco pipe, or by thruſting the noſe of a hand-bellows therein, and holding a pan of live coal (on which has been caſt a quantity of brimſtone) cloſe under the valve of the bellows all the time they are worked for this purpoſe, in order to check the fermentation.

will ſupport the health, and encourage the growth of the creature in a greater degree. It therefore appears to me very certain, that frequently loading the belly to ſuch a degree, muſt ſink it, as well as enlarge every member in it, whereby they are greatly injured in their retentive functions; which circumſtance, I doubt not, is the cauſe of cattle bred up with coarſe food, conſuming more in proportion to the progreſs they make in fatting, &c. than cattle that have been bred on fine food, when they come to be fed together; and after all, they never are ſo handſome. Of this I am ſo thoroughly convinced, Sir, that for my part, until cattle are at leaſt two years old, I purpoſe to keep them to good food, viz. good milk† until they can eat good graſs. When the graſs fails,—turnips, and a little hay or oats unthreſhed, until good graſs returns, which they are to be kept at all the ſummer. Againſt the winter, ſtraw and clover hay, or any ordinary wholeſome food, as after that period their ſhape cannot be injured.——But I have interrupted you greatly, Sir, in this explanation.

Phil. I ACQUIESCE in your opinion, *Agricola*; and ſooner than breed cattle upon any other principles, I would breed none at all.

WE will now, *Agricola*, ſuppoſe ourſelves upon the third year's management of our graſs field; at which period, or in the autumn of the ſecond year, it ſhould have a top-dreſſing of well

† SEVERAL things beſides milk have been directed by ſpeculative men of late for the food of calves, ſuch as hay tea, bean meal ſtir-a-bout, an infuſion of oil cake, &c. any of which will keep in life, but are greatly inferior to their mother's milk, which, when every circumſtance is fairly brought to account, ſuch as the fineneſs of ſhape, the greater heart and ſize in a given time, and better health, I may venture to aſſert it is alſo the cheapeſt that is or perhaps ever will be invented.

well rotten dung, or any of the other eſſential manures, finely ſpread, and left to be beaten in by the winter weather; and in the ſpring, if there ſeems to be any want of plants, ſow ſome more white clover to complete the bottom; after which back-harrow and roll the whole field, (taking dry freſh weather to do it in) and let it ſtand for hay. Let the aftermath get to a full growth before ſtock are turned upon it; refrain eating it too cloſe; avoid poaching the field in winter; and for the future make it at leaſt as often paſture as hay. Give it now and then a top-dreſſing of ſome of the above-mentioned manures.—Coal aſhes, if dry when laid on, and in a proper quantity, (four chaldrons per acre) as they give birth to a ſpecies of red clover, that has perennial roots, and proves good either for paſture or hay, for the ſecond dreſſing, will turn to good account.

THE field being now in a condition to make ſome return to the occupier, even in graſs, (and to the owner it is a new inheritance without fee-ſimple)—cannot therefore doubt, if he has a grateful agent, but ſuch an occupier will be permitted in the eighth or ninth year, (a little ſooner or later as circumſtances may require it) to break it up, under proper reſtrictions; as it will by that time be able to bear good crops of corn; whence by the ſtraw he will be able to winter more cattle, make more manure to improve other fields, and be ſufficiently refunded his former outlay, and rewarded ſuitably to his ſpirit and induſtry, and all without doing his landlord any injury; for it will, after it has been two fallowings in tillage, well worked, and manured, be in a proper condition for being laid down for a continuance with the beſt graſſes.

Agric. I really thought, Sir, it had been ſown down with the beſt graſſes.

Phil. They were, to the beſt of my judgment, the moſt ſuitable for it at that time, *Agricola*; but a change of circumſtances makes room for a change of the graſſes; and as the land is now capable of being laid for a ſheep paſture, that being the mode in which graſs continues longeſt, and after which no manure can with propriety be uſed as a top-dreſſing, as it fluſhes the graſs too much for their tender bowels; and as they are themſelves excellent manurers, the farm manure will in courſe fall due to other lands; yet for the ſake of keeping it in heart, (as it would be inexcuſcable folly to let it fall back again) it will be proper to ſupplant thoſe graſſes which are impoveriſhers when they ſtand to feed, (I mean the Ray-graſs and the Rib-graſs) and that they will do, if the premature mowings I formerly mentioned are not kept up; to avoid the expence of which, and other inconveniences, I think it comports both with reaſon and œconomy to ſupplant them.

Agric. PLEASE to inform me, Sir, with what ſeeds you would ſow it, and in what manner you would order it the ſecond laying down.

Phil. To give it the beſt chance for graſs, and at the ſame time make the moſt while in tillage, I ſhould prepare it for turnips by dunging it well, the fallow preceding its being ſown down. Theſe turnips, in dry weather, I ſhould feed off with ſheep as early in winter as I conveniently could; after which I ſhould ridge up the land, lay it quite dry, and leave it to be pulveriſed by froſt; next, as early in the ſpring as is con-

conſiſtent with making barley land, give it a thorough preparation for that crop,§ and ſow it as ſoon as a good ſeaſon offered; by which means, together with ſowing an early kind of barley,* and giving it a full ſeed, I might reaſonably expect to have the crop ready to harveſt (in any part of the kingdom) by the end of July. As ſoon as the crop was carried, (whether mown or reaped with the ſickle) I ſhould harrow up the ſtubble, employ people to gather it into heaps, and alſo every weed and ſtraw they could find, and burn them with all imaginable expedition. Which when done, and the aſhes ſpread, ſhould plow it down, that is ſpilt each ridge, and without loſs of time harrow it, and gather the weeds and ſtubble, if any remained, and burn and ſpread them as uſual. Then without delay I ſhould ridge it up again, harrow it well, and ſow the graſs ſeeds; taking care to harrow them lightly with a fine harrow, and roll them with a light roller, as before directed; all which may be completed in the month of Auguſt, if the weather prove favourable; but if it ſhould be a fortnight later, there cannot be any material loſs on that account; eſpecially if gentle rains follow the ſowing in a week or two.

THE ſeeds being ſown in this manner, *Agricola*, and as no ſtock is to be turned upon the field until the middle of April at ſooneſt, and then only young cattle for the firſt year, it will be a great advantage to the ſeeds if the weather is dry, even dryiſh, to roll them with a heavy roller in the month of November every year; as that operation fixes the ſoil cloſe to the roots of the graſſes, and prevents, in a great meaſure, the bad effects of froſt in winter.

* THE rath-ripe barley.

§ IF the land has occaſion for a freſh dreſſing, the artificial manure may be ſown in the ſame quantity and manner before directed.

IT remains now, *Agricola*, to mention the kinds and quantities of graſs ſeeds proper to be ſown per acre upon this occaſion, which are as follow; viz. of the *Trifolium Repens*, (white Dutch clover) ſeven pounds;—of *Trifolium Agrarum*, (hop clover) three pounds;—of *Bellis Perennis*, (common daiſy ſeed) two pounds, if ſuch can be had†; if it cannot be had, in lieu thereof one pound more of the *Trifolium Repens*; and three buſhels of well dreſſed hay-ſeeds, that abound with Sheep's Feſcue, Creſted Dog's Tail, and Poa Graſs; as all of them have perennial roots, afford ſweet and healthy herbage, and make a cloſe ſward.

THESE, *Agricola*, are briefly the ſteps I ſhould take in managing ſuch land in the above condition;——but in practice you cannot confine yourſelf to follow directions literally; you will meet with different impediments, and therefore will have occaſion to conduct your improvements as theſe and circumſtances require; in which, and upon every occaſion relative to your buſineſs, I flatter myſelf theory will be a ſatisfactory and faithful monitor.

Agric. To be be ſure, Sir, it is not in our power to do every thing at the preciſe time, nor perhaps in the ſame way authors direct; more than it is in the power of a commander of a veſſel to ſteer exactly at all times to a projection, or the tract another veſſel made on her voyage to the ſame port;—yet ſuch direction has its uſe, I apprehend; and upon that principle I beg, Sir, you

† I DO not know whether ſeedſmen are furniſhed with daiſy ſeed, but I am convinced it is a valuable ſheep-graſs, as they are fond of it, and it agrees with them;—hence as this ſpecies is a perennial, and makes a good bottom, it ſhould be cultivated.

you will favour me with further directions relative to ſowing down with, and cultivating artificial and natural graſſes.

Phil. THE caſes you mention, *Agricola*, are pretty paralled, I own; and your apprehenſion that directions are uſeful, I alſo admit, in ſome inſtances, may be juſt; but, by the by, directions are moſt uſeful to thoſe who alſo attend to a juſt theory, becauſe difficulties do often occur to the practitioner, which render it impoſſible to avail himſelf of the moſt copious and intereſting directions. For inſtance, what would it avail your ſeaman his being directed to ſteer by ſuch and ſuch bearings, when he had been driven quite out of view of them? In ſuch a caſe, if he does not betake himſelf to theory, he has not an equal chance to avoid ruin, that a perſon in that ſituation has, who does attend to theory. And juſt ſo it is, *Agricola*, with the huſbandman, who is directed to plow his fallow a certain number of times, and at ſtated periods of time; becauſe, if the weather proves ever ſo contrary, if he attends to the directions he muſt labour, whereby, inſtead of aſſiſting the ſoil, he moſt certainly will injure it. And ſimilar to his caſe are thoſe who attend to the ancient cuſtom which prevails in the north of England, of ſteeping or ſprinkling ſeed wheat with dunghill water. The conſequence of which is, if the taint is not taken off by accident, ſuch as a great wet after ſowing, &c. the crop is more or leſs ſmutted or ſlain, in proportion to the quantity of putrid matter it received by the ſteep.*

* I have lately been informed by a correſpondent of unqueſtionable veracity, that by dint of advice, and his conjecturing that ſteeping in dunghill water brought food near the young plants, he was prevailed on to uſe ſuch a ſteep, and to his ſad experience, found the whole of his crop that was ſo treated, (and none elſe, although on the ſame land, and had the ſame ſeaſon, &c.) effected with ſlain in a very diſmal de-

BUT it would be flat tautology to ſay any thing further to you on the advantage of theory, *Agricola*, as you have already heard ſo much concerning it, and have yourſelf very great conceptions of its nature and uſefulneſs. We will return, therefore, to our ſubject, and as far as I can aſſiſt you with directions, ſhall freely do it: But, in my opinion, what has been ſaid relative to the management of the field we have juſt been treating of, renders it unneceſſary to treat of the ſowing down good land; for if you are able to reclaim and manage land under the above predicament, there can be no doubt of your managing good land, becauſe the labour and manure in the former are at leaſt equal, often more than are wanted to prepare the latter; nor are the kinds of manure, ſeaſons, rollings, &c. &c. to be more ſcrupulouſly obſerved in the latter than in the former. And as to the kinds of ſeeds, if it is dry land you mean to ſow down, I know no better than thoſe I have already mentioned, unleſs the Sward is intended for pleaſure; in that caſe the daiſy, as it bears a white flower, and thereby will taint the verdure of the lawn, muſt be omitted.* If it is wet land, to lay it dry is the moſt eligible improvement.—The theory of which is briefly as follows:

FIRST, As water by the force of gravity and its fluidity, always reſorts to the loweſt ſituations; the drains muſt therefore all ter-

degree —I am ſincerely ſorry for my friend's loſs, I own, but as the event gives confirmation to my theory of that diſtemper, I enjoy on that account, a degree of ſatisfaction; and hope, as it is a fact to be depended upon, that the reader will profit by it.

* Drawings of the ſheep's feſcue, creſted dog's tail, poa graſs, &c. will be given, vide the plates; as alſo drawings of the moſt valuable artificial graſſes that have a variety of ſpecies, viz. the beſt burnet, ſaintfoin, lucern, &c.

terminate there, whether the evacuation from thence be by natural level, or by engine.

SECONDLY, If it is a clay ſoil that is to be drained, the drains muſt be near together, otherwiſe the tenacity of the clay will detain the water: whereas, if it is a gravelly ſoil to be drained, a much leſs number of drains will do, becauſe the pebbles of themſelves form innumerable channels, through which the water of courſe paſſes along, provided there is an open ſide below its level.

THESE being the extremes, *Agricola*, you will be at no loſs to adapt the method to any caſe that falls between them; and whether you make open or covered drains, that muſt be left to your own determination; for altho' covered drains are not only the moſt durable, if filled with ſtones, but alſo neateſt, and leaſt abridge the ſurface; yet the expence and want of opportunity may make it inconvenient.* There is one caſe, which ſeems an exception from what is above premiſed, *Agricola*, I ſhall therefore give ſuch directions concerning it, as I have found uſeful, *viz.* A clay ſoil, in which there are traps of ſand or gravel abutting to the ſurface in places, and communicating with reſervoirs of water, with their other extremities. When this is the caſe, (as it always is when you find ſprings in clay and loamy ſoils) direct your drain from your loweſt dam or level, to the loweſt ſide of the ſpring, if the diſſent is eaſy; if it is great, either abate the diſſent where the drain diſcharges, or

* WHEN a drain is filled with ſtones, care muſt be taken to lay them ſo deep that a plough cannot reach them, ſhould the ground be afterwards held in tillage, as is very neceſſary for an improve of the herbage, &c.

carry the drain to the ſpring in a ſlanting or ſpiral direction; for when a drain is laid with a great diſſent, the water ſoon makes it gulfy, and the ſides and top tumble in: And mind, *Agricola*, do not ſtop when you come to water, altho' it ſeems to run freely, unleſs you are through the trap or dike; becauſe, if ever ſo ſmall a partition of clay remains between your drain and the trap, your labour will not be effectual.

WHEN you have completely drained your land, *Agricola*, in order to furniſh it with proper herbage, (for it is not to be expected the herbage it formerly produced is of the beſt kind, ruſhes being the predominant product of ſuch ſituations) to eradicate which, and every ſpecies of the like trumpery, and alſo improve the ſoil, the moſt effectual way is burn-baiting, or what in the north is called paring and burning: And whether it be pared by the breaſt or foot plow, if it be ruſhy, the turf ought to be taken pretty thick and burnt to black aſhes.* As ſoon as burnt, if the weather is dry, let them be equally ſpread and harrowed, and the field gathered into ridges without loſs of time. And to facilitate the breaking it into mould, the plough or ploughs that ridge it up, ſhould have each three or four coulters

* WHEN aſhes are burnt red, yellow, &c. which they do by a great degree of heat, many of the moſt valuable particles for vegetable food are ſent off in ſmoke, &c. Beſides, when the ſoil has a mixture of ſand in it, it becomes exceedingly injurious to land, when much burnt, as may be learned by the pernicious effects of ſandy lime, &c. It is alſo very proper to have the turf dry before the heaps are made; and in all ſoils to make the heaps ſmall, (the ſize of a bee-hive is large enough) which both prevents the aſhes from being too much burnt, and the pared ſurface of the ſoil from being ſo exceedingly unequally heated, as it is when the heaps are large; becauſe the whole ſurface is covered with heaps when ſmall, and the benefit a field receives from being heated is very conſiderable.

coulters ſo planted as to ſcore the furrows three-fourths through. Or if it is more convenient, to roll it with a ſpikey roller pretty cloſe, that will anſwer nearly the ſame purpoſe, eſpecially if the ridges are made by thin furrows, which on every other account is alſo the moſt proper for this ſort of improvement.

WHEN the land is thus prepared, *Agricola*, which it is reaſonable to ſuppoſe it may be by the middle of June, provided you begin timely in the ſpring, you are to conſider whether turnips or rape is beſt ſuited to your ſtock, ſituation, &c. there being no occaſion to doubt of its ability to bear a crop of either to very good purpoſe, if it was not an entire *Caput Mortuum*; and the time of ſowing either is now about,* eſpecially if the rape is intended for winter food for cattle, ſheep, deer, &c. which it will anſwer to good account, if the land is well drained; and it will alſo, if freed early in ſpring, yield a crop of ſeed the following ſummer, worth from five to fifteen pounds per acre, according to the richneſs of the ſoil, goodneſs of the ſeaſon, and price of the year.

However, *Agricola*, ſhould this courſe be thought proper to be adopted, for your own benefit and credit, as well as in juſtice to the proprietor of the land, as ſoon as the rape is carried, the ſtocks ought to be pulled and laid on the tops of the ridges to dry, and then ſet on fire; and when reduced to red embers

* About 10lb. of the beſt rape ſeed, or *Braſſica Rapa*, is ſufficient for an acre, which ſhould, after the land is harrowed fine, be ſown very regularly, and harrowed again with a ſhort tin'd harrow, and light horſes; and when it is poſſible to foreſee a ſhower of rain, and every thing is ready, it will be a great advantage to the crop to receive it in a few hours after it is ſown, harrowed, water-furrowed, &c.

bers, they ſhould be ſtrewed regularly over the ſurface, which is a work of no great expence, and turns to conſiderable profit, inaſmuch as it not only furniſhes a freſh dreſſing, but by being ſo ſpread, burns moſt, if not all the weeds and ſeed that lie on the ſurface. The land being thus ordered, if it is a clay or loamy ſoil, and poſſeſſed of a tolerable degree of vegetable food, I would open the mid-ridges, with the double mould broad plough; or for want of ſuch an inſtrument, make three furrows on the top of each ridge, then harrow them over, and gather every ridge up again very neatly, abating in the depth of the furrow, as I approach the extremity of the ridges: and ſo let them lie until the ſeaſon of ſowing wheat, when I would ſow the whole field with that grain, giving it, as far as able to command them, the beſt ſeed, ſeaſon and culture; in which laſt, I ſhould certainly include rolling it, if the weather would permit, as ſoon as the roots had taken to the ſoil, for the whole nouriſhment of the plant, which is to be diſcovered by the leaf recovering its verdure, as I have before hinted.

AFTER the crop of wheat is carried, ſtubbles picked, &c. I ſhould water-furrow the land again, in order to carry off every ſipping of water, that either oozed out of the ſoil, or fell upon it; nothing being more deſtructive to land, in tillage, than lying wet; and ſo let it go for fallow the next ſummer; when, beſides giving it as many good plowings, harrowings, and rollings, as are neceſſary to clean and pulverize it, ſhould give it a good coat of ſome of the eſſential manures, as early in the ſummer as poſſible. And after it is plowed in, ſhould ſpread a little quick lime over it, and let it lie until the latter

end

end of Auguſt, and then ſow it down with graſs ſeeds, as I have before directed; but inſtead of the creſted dog's tail, would ſow fox tail, it being a ſpecies of Timothy graſs, which is both a wholeſome and luxuriant graſs, when ſown on a moiſt ſoil that is in heart; ſhould alſo abate a little of the quantity of white Dutch clover, and in lieu thereof, uſe rib graſs, and daiſy. It muſt, after what has been already ſaid, be quite unneceſſary to ſpend any more of your time, *Agricola*, in directing how the field muſt be treated in future; ſhall therefore give you my opinion of the culture of turnips, ſhould it be thought more expedient to crop with them than rape. Firſt, then, until the ſeeds are ſown, I ſhould make no difference in the preparation: In ſowing the turnips, an expert hand ſhould be employed for land that is under a courſe of burn-baiting; notwithſtanding the moſt extraordinary labour, if the ſoil is mixed with tough fibres, there is not a poſſibility of reducing it to a condition fit for hoeing the turnips. The turnips therefore ought to be ſown quite regular, and rather an over quantity of ſeeds, than too few;* for altho' they cannot be hoed, they may be thinned by hand, and the advantage of having a full ſtock of plants in the infancy of the crop is a good extreme, becauſe they ſhelter one another; and as turnips, like other plants, are fed ſome time by the ſeed, they do not injure the land by being thick, unleſs ſuffered to remain ſo, after they take their food from the ſoil; which this plant does not altogether do, until it has its rough leaves; and then it is proof againſt the fly, and alſo againſt the common run of ſummer weather, if the ſoil is in proper plight for ſuch a crop.

Agric.

* About a pound of ſeed to an acre, if ſown by hand.

Agric. SHALL be particularly obliged to you, Sir, for your opinion concerning that deſtructive creature, and the method to remedy its pernicious effects.

Phil. I SHALL ſtop to oblige you in that, *Agricola*, with the greateſt pleaſure, and my opinion on that matter is briefly this:

AT the time turnips are in their ſeed leaves, they are perhaps the richeſt food for inſects, that can be produced, being oily, aromatic, and tender: And at this very juncture, the whole fly genera are in the meridian of life and vigour;—— hence, it is, our turnip fields are attacked ſo univerſally, not only by one ſpecies of thoſe inſects, but by almoſt every ſpecies of them, from the ant to the beetle; eſpecially if the field has been dreſſed with dung immediately before the turnips were ſown; for which reaſon, *Agricola*, as well as for incorporating the ſoil, and dreſſing more intimately together, I adviſe you to have your land dunged as early in ſpring as poſſible, but mind have it clean firſt. This precaution, *Agricola*, and ſowing upon the ſurface of your turnip field immediately after the turnip ſeed has been harrowed, about a buſhel to an acre of quick lime, that has been fumigated with ſulphur vivum, or roll brimſtone, by throwing about two ounces of either finely powdered, amongſt as many knobs of burnt limeſtone, as will burſt into a buſhel of flour lime, at the very inſtant the knobs are ſtacked, and ſo do to every buſhel you intend to uſe; as the heat will diſperſe the ſulphur into vapours, which will in a great meaſure be detained by the lime, if you turn the parts on which it was ſtrewed undermoſt. By this

this means your lime will become extremely diſagreeable to the inſects; and if your land be proper, and in proper condition, and alſo favoured with a fine ſeaſon and good ſeeds, you need not much dread the fly.

Agric. WHY make a point of the nature and condition of the ſoil, Sir, with reſpect to the fly? You but now owned, that dunged ſoils, which juſtly may be eſteemed in condition, were rather more hazardous than others.

Phil. THERE is a ſeeming contradiction in that, I own, *Agricola*; and you do well to call upon me for an explanation: But as every man ought to diſcriminate between a real blemiſh and a miſconception, before he accuſes; and even when the former obtains, unleſs there is an unavoidable neceſſity for crimination, he will have reaſon to be better pleaſed with his own conduct, when he points out a miſtake or fault in his companion, by apologiſing for his own want of apprehenſion, than when he peeviſhly arraigns: But this by the bye; ſo pray accept my explanation without emotion.—Firſt then, what I mean by proper ſoil and in proper condition, is, that the ſoil abound with contaminated air, as well as other vegetable food; for on that circumſtance the ſucceſs of a turnip crop has great dependence; and the general criterion is the length of time the land has laid under graſs, and the condition it was laid in: For if it was well dreſſed with any of the eſſential manures when laid, the greater quantity of this ſpecies of contaminated air it will contain.

SECONDLY, with reſpect to the diſtinction, *a proper ſoil*, I mean a ſandy loam, a gravel of any complection a black earth, and the ſea ſands; as in general the other ſoils, particularly the clays,

are too compact for the tap roots and their horizontal appendages to penetrate.

THIRDLY, as to the aſſertion, that if thoſe properties did obtain, there would be little occaſion to fear the effects of the fly; I found my theory on analogy and facts, *viz.* That as all animals, languiſhing by hunger or unwholeſome food, are in greater danger, if attacked by diſeaſe or accident, than thoſe that are ſound and well ſupported; ſo are vegetables that are ſickening for want of proper food in greater danger, than thoſe that are well ſupplied with food, when diſeaſe or accident befalls them. Hence it is we ſeldom ſee turnips on improper ſoils, eſpecially if the ſoils are out of heart, recover from the wounds the flies give them: Whereas turnips on proper ſoils, that are in heart, if the weather is not altogether contrary, never fail to come about again, even when the leaves have been eaten to the ribs.

THE beſt method therefore that I know to ſecure you againſt the bad effects of the fly, is never to ſow turnips unleſs the land is altogether proper; and if the fumigated lime is alſo uſed, I venture to aſſert you will never loſe your crop by the fly.—I preſume I have now ſufficiently wearied your attention for this evening, *Agricola*; ſhall therefore mark a place for our next converſation, and cloſe the preſent.

Agric. I feel no wearineſs, Sir; but it is paſt the uſual hour: —So, for the preſent, adieu!

CON-

CONVERSATION XV.

AGRICOLA.

BESIDES the account of turnip culture you have already favoured me with, I ſhould be greatly obliged to you, Sir, for what remains on that head. Nothing can be more intereſting to me; and as I have had a pretty extenſive practice in that huſbandry, I ſhall, if you approve of it, communicate my thoughts as we go along, which will ſerve for the examination I ſome time ago propoſed to undergo.

Phil. I HEARTILY approve the propoſal, *Agricola*; and as we have already conſidered the preparation and nature of the ſoil, ſeed time, quantity of ſeed, and method to preſerve the crop from the fly; ſhall next turn our thoughts to the nature and advantages of hoeing; which proceſs, beneficial as it is, cannot in this caſe be practiſed, as the land has been pared and burnt, as I have before hinted: For altho' the furrows are, by the means recommended, I doubt not, pretty well broke, yet they would be very aukward to hoe.

Agric. BY ſowing the green top'd white turnip, as it goes little into the ground, except with its roots, which alſo keep nearer to the ſurface than the purple, yellow, or red turnip, we experience little inconvenience for want of hoeing, if we have plenty of aſhes and the ſummer dripping.

Phil. I CANNOT point out a better turnip for burnt land,

Agricola, provided you ſow regular: And as that turnip, by its ſpreading on the ſurface of the land, is not ſo much protected from the effect of froſt, as the long-rooted turnip; I ſuppoſe you contrive to feed them off before the froſts become ſevere.

Agric. WE certainly do when we ſtand our own friend; for altho' there is a poſſibility of preſerving turnips from waſting by froſts, by cutting off the tops and covering the roots in pits, as we do potatoes before froſts ſet in; yet that method is ſo expenſive, and there is no other effectual method that is leſs expenſive, that we cannot conſiſtently attend to it. And beſides the above convenience which peculiarly belongs to the green top'd white turnip, I never in practice have been able to find it deficient in any other point of utility: On the contrary, I have in many inſtances found it greatly preferable to any other, particularly when the ſoil approaches either to an extreme of richneſs or poverty. For when the ſoil is very rich, the long rooted ſpecies draws all to top: When poor, we ſee nothing except a tap root of ſome ſubſtance, and a ſtrunted ill-favour'd top; whereas be the ſoil ever ſo rich, the green top'd white turnips always turn: And when the ſoil is poor, if any turnip will grow, they will: And altho' the tops in that caſe are ſmall, the knot will be fairly turned, and conſequently of ſome value.

Phil. THESE are conſiderations well worth the huſbandman's notice, *Agricola*; nor are the green top'd white turnips inferior to any of the other kinds in taſte, ſolidity, ſize, or any perfection whatever. Hence it always has been a matter of ſurprize to me, that any of the other kinds are ſown in the fields, eſpecially as their ſeeds are in general exceedingly more deficient in point of vegetation (*cæteris paribus*) than the original *rapa*, or green top'd white turnip.

Agric.

Agric. I HAVE really, for ſome time, been of that opinion, Sir; and do always allow a fourth more ſeed of the long turnip to an acre, than of the flat turnip. But it is only when I have a peatiſh ſoil* that I do at all uſe it.

Phil. IF the long turnip deſerves the preference in any ſoil, it is in that you have mentioned; but I have often found the flat turnip exceed them even in that kind of ſoil, when the land was well rolled before the ſeeds were ſown: For rolling ſuch ſoils before ſown, when under turnips, make them better to hoe, and much firmer in their fleſh, than when the land is left in its natural looſe ſtate.

Agric. I have not practiſed that method I own, Sir; but it is very evident there is much propriety in it; for in the prime of ſummer, or turnip ſeed time, black ſoils abſorb ſo large a portion of the ſun-beams, that the ſeeds which are depoſited in it, are in a time of drought in the greateſt danger of being deſtroyed: Nor can thoſe capillaries, which I am convinced are ſo neceſſary for the tranſudation of the food of plants, be formed until the ſoil becomes compact, which rolling of all things ſeems the beſt calculated to anſwer. Indeed, I am of opinion, that turnip crops on all proper ſoils are bettered by rolling after the ſeeds are ſown, eſpecially the new light ſoils, whatever colour they be. Care, however, ought to be taken to avoid treading the land too much, and alſo to proportion the weight of the roller to the circumſtances of the ſoil and ſeaſon.

Phil. I ACCEDE to every one of your obſervations, *Agricola*, and

* A BLACK peat moſs, or rotten moor ſoil.

and think you ſo much maſter of turnip huſbandry, that we may take leave of the ſubject.

Agric. I SHALL only deſire you, Sir, to favour me with your opinion on the hoeing and drilling peculiar to this ſpecies of huſbandry, before you diſmiſs it.

Phil. I WAS going to paſs it, *Agricola*, but as you think it neceſſary, I ſhall with all my heart attend to it. And my opinion on drilling a turnip crop, is as follows; firſt, as drilling the ſeed gives greater ſpace to the plants than broad caſt, I would therefore in weak ſoils practiſe the drill, and increaſe the dimenſions of the interſtices as I found the poverty of the ſoil to militate.

Agric. PRAY what ſort of drill would you uſe, Sir?

Phil. The drill I have heretofore mentioned to you, which I purpoſe ſoon to give you a full deſcription of, ſows turnip ſeed very regular and expeditiouſly. But I have yet an eaſier method to recommend to you, viz. to ſow the field broad-caſt; and as ſoon as the plants have their rough leaves, take a double ridging plough, that will ſet to the ſize you intend the ſpaces between the rows; or for want of ſuch an inſtrument, a ſmall Rotherm plough, or a paring plough, and ſcore the whole field into rows or drills of twelve inches broad;* which rows are to

* THE ſhare of the plough that performs this operation ſhould be a little more than half the width of the interval, and have a fin or coulter on the land ſide, by which in making about, the turnip rows will be cut clean on each ſide, and the amputated turnips, weeds, &c. will be gathered in the middle of the interval, where they will ſoon rot if the weather be dry, which is the proper ſeaſon for this operation. And by keeping the ſhare ſharp, the plough will do its work well with a ſmall horſe, as a furrow an inch and a half deep is enough on this occaſion.

to be carefully thinned with the hand hoe as often as the growth of weeds, and other circumſtances, may require: And the interſtices or ſpaces between the rows, which may be from eighteen inches to two feet and a half broad, ought to be frequently hoed by a plough; the common rotherm plough will do very well to cleave down the furrows that were gathered when firſt thrown into drills, as alſo to give them their proper ſtirrings during the whole ſeaſon.

Agric. I DID ſuppoſe you would direct the intervals to be plowed now and then, in order to expoſe a freſh ſet of particles to the atmoſphere; and let thoſe that had become ſaturated, by being expoſed a proper length of time, communicate their acquiſitions to the crop.

Phil. YOU have in one breath, *Agricola*, anticipated all I had to advance on the theory of hoeing turnips, or any other crop: And the frequency of the ſtirrings, I doubt not, you alſo well know depends on the heart or condition of the ſoil, and weather.* For if the ſoil is weak, its particles are ſoon ſaturated, and therefore ought to be ſoon changed: Beſides, if ſoon ſaturated, they will alſo be ſoon exhauſted by the hungry fibres under the ſurface. Hence, we may compare this proceſs to a ſcanty provider, who muſt either go frequently to market, or his dependants will be involved in famine. Whereas the œconomiſt provides plentifully, and conſequently requires time to make room for a freſh ſupply.

Agric.

* As ſoon as the field is dry after a heavy rain, it ſhould be freſh hoed.

Agric. BY this I plainly ſee you intend the pooreſt ſoil the moſt culture.

Phil. I REALLY do, *Agricola*; and I doubt not that you and every huſbandman of ſenſe and experience in the kingdom, have ſeen this theory verified.

Agric. I KNOW it well, Sir, and am clear in the opinion, that by hoeing a turnip crop, eſpecially if the field is poor, in the above manner, the crop will be of much greater value than it otherwiſe would be. And beſides, I think the intervals after the turnips are come to their full growth, or nearly ſo, may be turned to ſome account by planting them out with Siberian Borecole,* at about ſixteen or eighteen inches apart. For as that is a hardy plant, it will ſtand the winter, and afford good feed for the cattle or ſheep that pick up the remainder of the turnips; ſuppoſing the prime to be carried into hovels, &c. to feed cattle, or to graſs land, where the refuſe of them, the treading of the ſtock that eat them, and their dung and urine, will much improve the herbage if the field is dry.

AND beſides theſe advantages, I think, Sir, it will be a means of rendering the future crops nearer an equality on every part of the ridges, than they would be, when the intervals are in fallow all the time the turnip rows are under crop.

Phil.

* THE ſeeds of the colewort or Siberian Borecole, to anſwer this purpoſe, ſhould be ſown about the middle of July; and when the plants are pretty ſtrong, or rather when the turnips need no more weeding nor ſtirring of the intervals, they may be planted (perhaps in September).

Phil. I HEARTILY approve the thought, *Agricola*, and do ſincerely wiſh you the ſucceſs you deſerve: And if you will promiſe me your aſſiſtance, we will proceed to deſcribe the manner of treating the field that we ſuppoſed put under turnips after it had been pared and burnt.

Agric. SHALL be greatly obliged to you, Sir; and what occurs to me relative to the matter in agitation, ſhall propoſe it.

Phil. IF the field is not a thorough rich ſoil, and dry, as ſoon as the turnips, &c. are eat or carried off, if the weather is dry, if not, ſhould wait until it is ſo, I would have the ridges opened in the mid-ridges by a double mould board plough; or for want of ſuch an inſtrument, make three furrows with the common plough, as before directed, and then gather up every ridge as neat as poſſible, and ſo let them lie until the ſeaſon of ſowing oats; when I would put them under a crop of the beſt of that ſort of grain I could procure, and allow at leaſt four buſhels of ſeed to an acre, which I would harrow firſt with a pair of long tin'd three horſe brakes, to the amount of two double;* and alſo two double, with the cloſe ſet, ſhort tin'd harrow; and before I left the field, or as ſoon after as poſſible, have it water-furrowed or gripped,† and the fences put in effectual plight: So leave it in full expectation of an ample crop.

THE harrowing, you allow, Sir, is at leaſt double what is given to oat land under ſuch culture, in a general way; but I

* FOUR times along every break or harrow breadth.

† A TERM for open draining in the north of England.

own, for my own part, I entirely agree to the courſe, eſpecially as the ſoil is as we have all along ſuppoſed, only in tolerable heart; for I make a difference between ſuch land, and land in great heart or condition, with reſpect to harrowing, as the former requires every particle of the ſoil to be brought into action, to ſupply the demands of the crop; whereas the latter can ſupport its crop with perhaps one fourth of its contents in action.

Phil. WHILE you purſue that idea, *Agricola*, there is little fear of your committing any great error in the above eſſential branch of huſbandry; for I think you incapable of leaving even the richeſt ſoil, until the mould is ſo pulverized, as to prevent the fowls from picking out the ſeeds, or the drought from ſcorching it for want of cover.

SHOULD next, *Agricola*, if the crop of oats proved good, and the land could be conveniently continued in tillage a year or two longer, ſow it again next ſpring with oats; and then, as ſoon as the crop was carried, make it a winter fallow; and alſo as much of the ſummer as it required to clean and pulverize it ſufficiently; and alſo give it a good dreſſing of black dung, or ſome of the other eſſential manure: all which, I preſume, may be compleated by the middle of Auguſt, when I ſhould ſow it off with graſs ſeeds, as before directed * in every particular.

Agric.

* PROVIDED the dung is ſhort, the graſs ſeeds will grow better for its being put into the land immediately before the ſeeds are ſown; and turnips will alſo grow better, when the dung is put in immediately before they are ſown, than when the dung has been put in early: It is therefore to be oberved, that it is only to avoid the fly, that I have recommended dreſſing for that uſeful eſculent ſo much before hand.

Agric. I CONCLUDE your directing the land to be dreſſed with black dung, or ſome other eſſential manure, in a little time after burn-baiting, abſolutely neceſſary: For, by *theory*, it is clear, that the aſhes are an inſtrumental manure, and conſequently, together with the heat they firſt put in the land, urge the particles it contains to act with uncommon precipitation. Hence it is that land, which is pared and burnt, commonly falls out of heart under the third crop, even when it has been dreſſed with lime along with the aſhes.

Phil. IT is a very unwarrantable practice, *Agricola*, and what every landlord ought to object to, uſing lime at the ſame time land is full of live aſhes, or indeed until the land has been repleniſhed with a ſtock of freſh particles from dung or other eſſential manure, after a courſe of burn-baiting, as by ſuch treatment good land may be reduced to irreparable poverty. Whereas if land is made a good fallow, and refreſhed with dung, &c. after the ſecond crop, a landlord may enrich his tenant, and do himſelf no harm, by allowing him to put hide-bound, cold or moſſy paſtures, and even meadows that fall under ſuch predicament, under a judicious courſe of burn-baiting.*

* IT is particularly neceſſary that every proprietor and occupier of land, when they ſow down land with and for graſs, order it to be put full of well rotted dung at the time of laying down; for altho' it may be attended with inconvenience to procure it at that time, it will make an ample return, and be a ſaving even in the article of manure, as it will have a greater effect in generating that ſpecies of contaminated or polluted air, which, by experiment, is found ſo friendly to vegetation, than ten times the quantity uſed in top dreſſings will have.

Agric. UNDOUBTEDLY dung will have the effect you mention, Sir; but the misfortune is, we cannot always command it in proper quantities.

Phil. IT may be difficult, *Agricola*, to command the proper quantity of dung that is neceſſary on ſuch occaſions; but ſuch difficulties muſt be combated and overcome, if you are either your own or your landlord's friend. Indeed it is ungenerous of a tenant, to requeſt his landlord's conſent to break up land on any other footing, as much ſo as it is cruel of a landlord to deny his tenant to take up ſuch land as I have inſtanced, if the tenant engage faithfully to purſue ſuch mode of improvement.

AND with reſpect to increaſing the quantity of dung, I do not know a more likely means than abandoning the lazy and abſurd method of foddering in the field; and, in lieu of it, winter all the cattle in houſes, farm-yards, &c. By which you will not only make more but better manure, avoid poaching your graſs land, make your hay laſt longer, and dreſs your fields more regularly, but you will alſo have earlier and better graſs. For it is full as rational to expect a horſe to make a good day's journey, that has been rode all the preceding night, as it is to expect a field, that has been eaten all the winter, to yield as much hay or paſture in ſummer, as if it had been freed all winter.

Agric. THOSE who fodder in the fields, boaſt of the vaſt facility with which they ſtack their hay, and the ſaving in cleaning

ing their cow-houſes, &c. But with me I own theſe are very inferior conſiderations to thoſe you have inſtanced; and I have long looked on the practice with aſtoniſhment, as the leaſt attention to the nature of preparing manure inconteſtably evinces the abſurdity of ſuch a practice: For it is not to be ſuppoſed that the dung of cattle, ſcattered in the open air immediately as diſcharged, can ever ferment. In ſhort, I am of opinion the land is more beneſited by the urine of cattle ſo foddered than by their dung, eſpecially as the graſs that grows near the plots is diſliked by cattle either in hay or green; and where they lie, there is generally a want of graſs for one year at leaſt.

THERE is, beſides what has been mentioned above, another effectual method of increaſing the quantity of dung, *Agricola*, viz. by cutting the ſtubbles very low at harveſt, or otherwiſe mowing them, and carrying them home to litter the fold, &c.

Agric. I AM now very ready to ſubſcribe to that opinion, Sir; for altho' it is pretended, and I own I once thought it right, that the ſtubble, by being left high, kept the land warm, and therefore was beneficial to it: But I am now thoroughly convinced it is fallacious; and that the greateſt benefit land can receive in winter, if not under crop, and kept dry, is by being expoſed to froſt: And I am alſo clear, that ſtubble cannot become ſo ſerviceable to land, when left to rot on it, as when it has received the advantage of being mixed with the dung and urine of cattle in a fold, and carried to it a real eſſential manure.

Phil.

Phil. YOUR remarks, *Agricola*, are much to the purpoſe; but I know you neither wiſh for, nor expect me to dwell long on complimenting; ſo ſhall deſire your attention, while I explain my opinion on water, as an improver and manure to graſs land.

FIRST then, water, as we have before hinted, is never ſerviceable to vegetation, unleſs it be in a mixed or heterogeneous ſtate. It is indeed hardly poſſible to find it otherwiſe: But the ingredients it is mixed with, ought to be examined, leaſt by applying it with a deſign to improve or manure graſs land, it prove a deſtroyer of it; and the moſt ſimple general criterion to diſtinguiſh thoſe that are friendly to your purpoſe, from thoſe that injure it, is their ſoftneſs: For in ſoft water, little elſe is found but loamy or abſorbent earth, and perhaps a little alcaline or ſea ſalt, all of which are truly ſalubrious; whereas hard water is mixed with the moſt pernicious ingredients, ſuch as calcarious nitre, agaric, copperas, allum, &c. and ſometimes with arſenic itſelf.

THERE can be no need, *Agricola*, of giving you a criterion to diſtinguiſh hard water from ſoft water, as you have undoubtedly attended to making a ſoap lather, the boiling and burſting of peas, &c.

YOU may alſo judge pretty juſtly of the ſuitableneſs of water for your purpoſe from the ſtratum it paſſes through: for water that iſſues from coal, iron, ſtone, copper, lead, tin, &c. are totally oppoſite to it; but water that iſſues from chalk rock, lime-

ſtone,

ſtone, free-ſtone, gravel, ſand, &c. in general are friendly; as are alſo river and rain water.*

FROM what has been ſaid, *Agricola*, I preſume you will be able to diſtinguiſh the waters that are capable of aſſiſting vegetation from ſuch as injure it; and when you have found a ſtream of the former, if it is in your power to carry it through a ſcullery, a waſh-houſe, &c. or even a farm-yard, you will greatly improve it.

THE next thing is to apply it, the ſeaſon, ſoil, and ſituations that are moſt neceſſary to ſuch improvement, and they are briefly as follows.—With reſpect to the application and ſituation, the latter ought to be ſloping; and facing the eaſt, ſouth, or weſt. Hence the water, by being convey'd along the higheſt ſide, nearly in a level, if the land is free from holes, furrows, &c. as all land deſigned for this ſort of dreſſing ought to be; and the ſtream pretty briſk, twenty or forty yards in breadth, may be flooded from one gap in the aqueduct or main channel. The quantity of water that is let over the ground, is to be regulated by the nature of the ſoil, the heat of the ſeaſon, and hang of the ground, in the following manner. If the ſoil is ſandy, gravel, or marly, or chalk, which are the beſt for this ſort of huſbandry, and the hang great, the water ought to be ſent on in the moſt conſiderable quantity, and continued the longeſt,

* THE circumſtance of river water being friendly to vegetation, proves that the bad qualities of mineral water may be blunted by a copious admixture of nutritive particles, filtration, &c. For in rivers of any magnitude, there undoubtedly is a quantity of hard water, altho' taken in the groſs, they are all ſoft.

longeſt, particularly if the weather is warm, and a ſouth aſpect. When one break or portion is watered properly, which may be pretty well judged of by the graſs turning white below, and a yellowiſh green above, another break or portion is to be flooded, which is done by filling the gap where the water was ſent off over the firſt break, and opening one over the ſecond, and ſo of all the reſt, until the whole field is flooded, taking care that none be miſſed, as alſo that none be overdone.

AND in order to ſet the growth of a field as equal as poſſible, at the beginning of the flooding ſeaſon, which is as ſoon as froſts are pretty well paſt, perhaps in *March* in ſome parts of *England*, in others *April*, ſooner or later, as the ſoil, ſituation, and the latitude require, it is neceſſary to flood but for a few hours in one break, by which the field vegetates equally: after which ſlight courſe, repeat the flooding in the ſame order, but for a longer time on each break or portion.

IT would be miſ-ſpending your time, *Agricola*, to give a detail of all the various caſes that the different ſituations, &c. occaſion in the practice of flooding graſs land, as the bare mention of watering none too much, nor too little, according to the above criterion, I know is ſufficient to guide you in diſpoſing of your aqueducts and lateral drains, as well as in conveying the water from one field to another, as in ſending it over any plot or field according to art. Nor need I tell you, that where you have little water, you muſt not attempt to dreſs much land; for a hungry watering, is ſimilar to a hungry manuring of another kind. Nor can I doubt of your being very

very clear that the water muſt not be allowed to ſtagnate, neither muſt it glide over the land in a full ſtream, but trickle through the herbage with ſolemn pace.

WITH reſpect to an account of the uſefulneſs and advantages peculiar to this kind of huſbandry, as I have at this time, I believe, quite exhauſted your patience, *Agricola*, I ſhall defer it until you next favour me with your company, leſt you virtually, altho' you cannot literally, announce this a dry converſation.

Agric. IT is pleaſing to ſee you in ſuch ſpirits, Sir, after the fatigue of a whole evening ſpeaking; and I can aſſure you, I am at the greateſt diſtance from being tired, or thinking it a dry converſation, at any rate; for the ſubject is quite new to me, and conveys much profitable inſtruction; but as it is quite your hour, I beg to make my exit: and ſo, Sir, your ſervant.

CONVERSATION XVI.

PHILOSOPHUS.

BESIDES what was premiſed in our laſt converſation, relative to flooding graſs land, *Agricola*, I think it neceſſary to inform you, that it is improper to flood new lands, and land ſown down with red clover.

Agric. I SHALL not attempt it, Sir; but as I have found a part of my farm properly ſituated, and alſo a proper ſoil for flooding, I purpoſe bringing it under that huſbandry as ſoon as I can conveniently: Should be glad therefore to have your inſtructions what ſort of graſſes to ſow it down with.

Phil. THE beſt watered meadows that I have ſeen, *Agricola*, abound with common daiſy, creſted dog's tail, rib graſs, the *Anguſtifolium*, and white clover, than which I can adviſe you to nothing better: Sow them pretty thick, mow them two years, and paſture them one, before you begin flooding; which do gently at firſt, and let the weather be quite ſeaſonable, and your water alſo pretty rich, which you may do by damming it a little before it enters the field, and throwing a quantity of dung into it, if you have no other opportunity of enriching it, which by being frequently plunged by horſes or cattle being drove through the dam, will impregnate the water with its virtues. You had need alſo to attend to the health of the herbage,

herbage, *Agricola*, which you will deſcry by its verdure and growth; for vegetables, as well as animals, may ſicken by a change of food, eſpecially if care is not taken to introduce the new food in convenient portions. And now, *Agricola*, I ſhould be glad to hear you explain the *Theory* you have formed from what has been ſaid on water, as an improver and manure for graſs land.

Agric. ALTHO' I am not ſo ſanguine as the gentlemen you formerly mentioned* in my expectations of the effects of water, for they indeed alledge it is every thing to vegetation, yet I am thoroughly convinced it is very ſerviceable when it contains nothing but vegetable food, and is applied at the time that vegetation is going on; that is, when there is a proper degree of heat in the ſoil and atmoſphere, provided the organization and contexture of the plant are ſuitable thereto: And this, Sir, is my theory, and the reaſons that ſhall regulate my conduct, when engaged in that ſpecies of huſbandry, if you approve of them.

Phil. THEY are, in my opinion, very good concluſions, *Agricola*; but as theſe converſations may fall into the hands of perſons that may wiſh to know the particular reaſons why you ſo conclude, I doubt not but you will anſwer the following queſtions, viz.

FIRST, Why are you leſs expectant of the virtues of water as a manure, than thoſe gentlemen that have proved by experiments that it contains all the conſtituent parts of vegetables?

* PAGE 91.

Agric. It is not that I doubt of the truth of thoſe gentlemen's aſſertions, Sir, for I am thoroughly convinced that rain, river, and lake water, and many other waters that receive the influence of the ſun and air, are blended with the other elements or primitive atoms that conſtitute vegetables: Nor can I doubt of its being exceedingly neceſſary both as a vehicle and menſtruum, and therefore highly uſeful: Yet I humbly preſume, as we continually ſee a difference between the produce of good and bad land, even when they are watered alike; and as the produce of the rich or good land is always beſt, it follows that altho' water is a moſt neceſſary ingredient, it is capable of being improved; neither is it the beſt matrix for plants in general, as I could demonſtrate from the known properties of ſtagnated water, the vitiated thin food it yields, its ſtrong bias to putrefaction, &c.

Phil. I WILL not trouble you to illuſtrate that point any further, *Agricola*; for altho' water is an element abſolutely neceſſary to the work of vegetation, and as you obſerve, may and doth often contain all the other elements; yet it may be improved by the ſoil, and by adjuſting its quantity to the nature of the plant, &c. and ſuch improvements are truly neceſſary both to render it uſeful, and prevent its having very pernicious effects.

IN the next place, *Agricola*, I beg you will explain the organization peculiar to the graſſes you think moſt ſuitable for flooding.

Agric. I FIX the criterion in the conformation of the ſtalk, and give the preference to thoſe that are flexible and compoſed of

of a congeries of fine capillaries ;* and reject thoſe with tubular ſtalks.† Theſe, Sir, are the marks that I have attended to ; and I hope you will inform me if ſuch conformation is not agreeable to the laws of capillary motion.

Phil. I ANNOUNCE them altogether agreeable thereto, *Agricola*; and muſt tell you, that you remark with ſuch judgment and practical certainty, as render it needleſs to take up any more of your time to enlarge on that head : ſo ſhall proceed to deſcribe the uſes to which flooded graſs are beſt applied ; and manner of doing it.

WITH reſpect to the firſt, *Agricola*, I am of opinion they anſwer the feeding of milch cows and young cattle beſt of any thing ; for altho' ewes and lambs, and ſheep of all ages, are put to this ſort of feed, and they ſeldom miſs fattening ; yet if they ſhould be kept long after, there is a hazard of their proving unſound ; and indeed the hazard of death by diſorders in their bowels, is not leſs than 10 per cent. diſcount ; and the reaſon is very obvious from what has been already delivered, when we treated of the rot of ſheep. For altho' all the air drawn into the lungs by reſpiration, does not enter the blood veſſels, as you might probably conjecture from what I formerly told you, yet undoubtedly the ſubtile ſpirit or tranſuding principle doth enter the blood in the lungs ; and if it is fraught with putrid particles, ſuch as a too moiſt ſituation often abounds with, the worſt

* Such as the daiſy, rib graſs, white clover, &c. &c.

† Such as bents, meadow, oat, &c. &c.

worſt of diſorders are inevitable; eſpecially in thoſe animals that are not apt to, or capable of, a copious perſpiration. I therefore adviſe you to feed flooded graſs down with cattle, until it is time to free them for hay, which probably will be towards the latter end of May: And as to the manner of feeding them down, little elſe is to be regarded, than the having them dry before the cattle are turned upon them; for if they are turned in while the ground is wet, the graſs ſoon becomes dirty with the mud that rubs off the feet of the cattle, which prevents their eating it; the ſurface becomes poachy, and the water ſtagnant, than which nothing can be more deſtructive to both land and ſtock.

WE will now turn our thoughts to the culture of artificial graſſes: and firſt of LUCERN.

ALTHO' this graſs is far from being generally cultivated in theſe kingdoms, there can be no doubt of its having been in high eſteem in the days of *Virgil*, *Columelle*, *Palladius*, *Varro*, and other ancient writers of huſbandry, who have thought it deſerving their beſt recommendations as well for fodder as green feed; and I believe thoſe who have cultivated it properly, in modern times, will chearfully beſtow the warmeſt praiſes on it for the like uſes.

THERE are a great variety of ſpecies of it; but that which is the moſt beneficial to the farmer, has a perennial root, and annual ſtalk, which riſes to two or three feet high in good ſoil, and is well ſet with leaves at each joint; from which alſo

ſpring

ſpring numerous branches: The leaves nearly reſemble the leaves of hop clover, and the flower that of tares both in colour and ſhape: the ſeed pods are compreſſed, and contain ſeveral kidney-ſhaped ſeeds. It is the Medica of the antients, and called *Fœnum Burgundiacum*, i. e. Burgundian hay, by ſeveral botanic writers, and is the only ſort kept in reputable ſeed ſhops.

THE ſtalks and leaves of this excellent vegetable, when it is in a proper ſoil and cultivation, are of a deep green colour; but on improper ſoils, and under bad culture, they are rather yellow than green.* The root of this plant, when it yields a beneficial ſheer of fodder, is from four to twelve inches diameter, and the ſmall roots very long; from which it is clear that the roots ought to be at a good diſtance one from another; which at once ſhews us, that the drill huſbandry muſt be the beſt mode of cultivating it; and from experience I am authoriſed to ſay the ſame.

Agric. PLEASE, Sir, to favour me with an account of your method of culture, from the drilling of the ſeeds to reaping the crop.

Phil. WITH all my heart, *Agricola*; you ſhall have it from the preparation of the ſoil through every period of the courſe; and that in the cleareſt and moſt conciſe manner I am capable of.

* THE beſt ſoil for lucern is a dry, deep, gravelly earth, or dry loam, that has more ſand than clay in its compoſition.

FIRST then, I had my field for Lucern, by the middle of April, well plowed, harrowed, and made very clean; and as ſoon after as the land was dry, or rather between moiſt and dry, I ſtruck my drills an inch and a half deep, and the rows twelve inches apart, and laid in them about 10lb. of ſeed per acre, and covered it carefully up with fine mould; all which the drill, I ſhall hereafter deſcribe, performed by the aſſiſtance of one man. Nothing more is to be done to the field until the lucern is in bloom, and then it muſt be cut cloſe by the ſurface of the drill, and the tops carried off to be uſed as green feed for horſes, which purpoſe it anſwers to good account; for thoſe horſes that get it, require no corn, will be hearty and uncommonly ſleak ſkin'd, and put in ſuch a thriving way, as hardly can be procured by medicine and the moſt ſkilful management. As ſoon as the firſt ſheer is carried, the intervals between rows ſhould be hoed, and the roots earthed a little: And in three or four weeks after, the ſtalks will be in flower again, when the ſame proceſs of cutting, carrying, and hoeing, is to be repeated; and again in a few weeks, another ſheer will be ready, which as it is the laſt for that ſeaſon, let it ſtand until it is nearly hard, by which means it will be eaſier made into hay. Feed down the ſhoots it makes after, with cattle during the winter, or ſuch part of it as the weather will permit, taking care to free the field in wet weather, and pretty early in the ſpring. The ſecond year's treatment muſt be nearly the ſame as the firſt; only in the ſecond winter, and always after, cover the roots ſlightly over with fine mould from the intervals.

The

THE third year, in the month of November, if the weather is not frosty, take away every other row, and plant the roots two feet asunder, in land prepared as I have before shewn; and you may have it nearly in the same perfection as the first field; for the roots by this time being full of vigour, are very apt to strike: After this, still keep the rows and intervals clean, and the latter well hoed, which may be done with a full or cultivator, as they are two feet asunder; and as the roots will still increase in size, so will the crops, and may be held in vigour for half a century.

THIS assertion is only founded on report, I own, *Agricola*; but the author of it we have no cause to dispute; for the plant itself affords ample testimony of it, the crown of it being a congeries of concentric circles, whose number exactly corresponds to the number of years it has been in growing, similar to a tree, and probably may be of equal duration; and on every circle is a row of stalks proceeding from little knobs or carbuncles, which in old healthy roots may, I doubt not, in number amount to eighty or a hundred; for on a root six years old, I have told forty-seven stalks.

I SHALL on this head only intimate to you, that after you have taken your last crop or sheer for the year, which I have already told you may be made into hay, if not too late in the season, I recommend eating it afterwards with cattle, until the vegetation for the year ceases, and then earth the roots over slightly.

UPON the whole, I recommend the culture and preſervation of this plant, equally with old meadow ſward, to all proprietors of land that have land ſuitable to grow it; and a compliance thereto to all tenants, as the feed it affords, either green or dry, will be often double the quantity that can be cut from, or eat on, an old ſward of equal meaſure and quality: And that feed full as good in every reſpect as any graſs whatever.

SHALL in the next place, *Agricola*, mention a few particulars relative to the culture and uſe of *ſaintfoin*, or *ſanfoin*, as it is ſometimes called.

THE beſt ſoil and ſituation for ſaintfoin, are thoſe which are beſt for lucern: However, I ſhould on ſuch ſoils give the preference to lucern, I own; becauſe of the two, it is far the quickeſt grower, and alſo as ſweet and valuable feed. Saintfoin, in my opinion, is to be cultivated only as a ſuccedaneum for lucern on poor ſoils; and will, I doubt not, anſwer the farmer's account better than any other graſs yet in uſe in theſe kingdoms, as it is very good feed for ſheep in winter, for cattle in ſpring and autumn; and furniſhes a crop of hay in ſummer, of greater conſideration than any artificial graſs on poor land.

HENCE, thoſe who have dry, gravelly, and even quarry lands, that have been long in corn, and turn out to little account in graſs, may better themſelves by turning them into ſaintfoin meads. The preparation is ſimple, and of little expence; for nothing more need be done than to clean the land by a ſummer fallow, looſen it by deep plowing, and let it have the winter's froſt. In the ſpring, lay the field as level as can be con-

veniently done; and when dry, ſtrike it into drills, conſiſting of a ſingle 'bout of a plough. The diſtances between thoſe drills, from outſide to outſide, ought to be three feet.

THEN on the drills, after they have been raked or harrowed fine, ſow two rows of lucern, at about eight or nine inches diſtance; the grooves for the ſeeds muſt not be above an inch deep, and the ſeeds ought to be lightly covered with fine mould; for the ſaintfoin ſprings with a large head; and therefore if a heavy or hard cover is laid over it, it cannot come to light.

IN the three feet intervals, ſow oats, or if the land be good, barley, which when ripe, muſt either be mowed or very low ſhorn. The intervals in future muſt be plowed, cleaned, and manured ſometimes, if the land is poor and manure can be had; but as ground will be wanted to make the hay on, every other interval ought to be left for that purpoſe. Therefore one half of the intervals can only be plowed every year; and to make the moſt of the land, and alſo the better to fit it for drying the ſaintfoin upon, the interval that is intended to be kept for drying ground firſt, ought to be ſown down with red clover amongſt the oats or barley, which will be fit to mow along with the ſaintfoin, and probably will greatly increaſe the crop. They will cure or hay with much the ſame labour, for both kinds require frequent turnings to hay them, as they are juicy plants; the clover however is moſt ſo; and the ſaintfoin being of an open or buſhy nature, will prevent the clover

from becoming too compact either in the ſwarth or ſtack. As ſoon as the aftermath of the ſaintfoin is fit to feed off, by which time the clover will again be got to a pretty good growth, plow the clover down, (a trench plow will do it beſt) and it will cauſe a fermentation in the interval, which will greatly benefit the ſaintfoin in the drills. And in order to prepare the ſet of intervals that have been in fallow for anſwering the like purpoſes, ſow them down in Auguſt with ſome kind of clover, which will be ready for cutting along with the ſaintfoin next ſummer.

By this means very conſiderable crops of hay may be raiſed, even on poor land, for a ſeries of years, with little expence; as the ſaintfoin is of long continuance, and the ſeed is procured at a very moderate price; and leſs than a buſhel being ſufficient ſeed for an acre in the drill huſbandry, which on every other account, as well as ſaving of ſeed, you will find the moſt convenient and profitable mode.

From what has been ſaid, and that drawing*, *Agricola*, you will ſee that ſaintfoin is a deep rooting plant, and that it conſequently requires deep plowing, and ſoil with an open bottom to ſuit its growth: And experience evinces, that when the roots get deep, the plant does not exhauſt the ſurface, but draws its food from the lower ſtrata, by which means the nutritive juices, which ſunk through the ſtrata next the ſtaple ſoil, when under corn, are now collected for the uſe of an uſeful crop: A circumſtance that will, or ought, to engage the occupiers of ſuch open-bottomed lands to make trial of ſaintfoin, altho' it may be an uncommon attempt in their neighbourhood.

Agric.

* Vide Plate, Number 4.

Agric. As deep open ſoils are moſt ſuitable for ſaintfoin, I apprehend that ſtrong clays muſt be bad, if not the worſt, ſoils for that plant.

Phil. THEY are ſo indeed, *Agricola*; and on ſtrong, wet clays, it will be loſt labour either to ſow or plant it.

IT would be miſpending time, *Agricola*, to enlarge further on the culture of ſaintfoin, as your own ſagacity and knowledge in the cultivation of graſſes will ſufficiently direct to make a judicious experiment or two, and thoſe will compleat the practice: Shall ,therefore, now proceed to give ſome account of the culture and uſe of burnet. BURNET (the kind I mean to recommend) is a native of Britain, and may be conſidered as a moſt efficacious ſelf phyſic, appointed by nature to remedy maladies brought on creatures that feed upon vegetables, by colds, hard labour, ſurfeits of any kind, and even ſmall degrees of poiſon; as it is a powerful *Alexipharmic*. Beſides its medicinal virtues, it is highly valuable as food, either green or in hay, for horſes, ſheep, and other cattle; and the milk, cream, and butter, which are produced by cows fed on it, being remarkably rich and fine flavoured.

AND as it is a graſs of long continuance, having perennial roots, affords a plentiful feed at all ſeaſons of the year, and will thrive well in a promiſcuous ſtate, I eſteem it a neceſſary appendage to the laying off paſture or meadow grounds, eſpecially thoſe that are deep of ſoil, be it gravelly or earthy, and between a moiſt and dry ſituation.

IT may be ſown amongſt white clover, hop clover, and fine meadow hay ſeeds, about 8 or 10lb. to an acre: It may likewiſe be cultivated in the drill huſbandry to a good account; but I own I would rather have you try it firſt broad caſt, and mixed as I have already mentioned; as then it will be clean eaten; whereas when it is cultivated alone, ſtock that have not been brought to it by long uſe, will make waſte of it; and even thoſe that have been, year after year, at it, turn from it after a moderate repaſt, and will feed on other herbage if within their reach. This I have remarked with certainty; and it is my chief reaſon for recommending the culture of burnet in a promiſcuous ſtate.

Agric. I HAVE heard it aſſerted, that ſtock would not eat it heartily at any rate; which aſſertion, I ſuppoſe, has been founded on obſerving ſtock turn from it before they had filled themſelves; but that with me will make nothing againſt the value of burnet; for as it has ſo many medicinal virtues, I think nature itſelf will object to make it the entire food; as a too frequent uſe, or a too large portion may, as in other drugs, deſtroy the benign effects thereof.

Phil. I THINK you have very properly accounted for the ſatiety, with regard to its being medicinal, *Agricola*; nor need we doubt of its being a rich food, as its effects have ſhewn it, and conſequently will ſooner ſatisfy the appetite than lean food. Another advantage peculiar to burnet is, that a freſh ſtock of foot ſtalks and leaves, ſhoot immediately after the old ones are cropt, or mown from the crown of the root; and the

the old ones ſhrivel up inſtantaneouſly, which prevents their draining the root; as the ſtubble of moſt other perennials doth by bleeding, if I may ſo term it, many days after the amputation.

AND to diſtinguiſh the fine burnet from the coarſe, ſpurious ſpecies, I flatter myſelf you will need no other criterion than the drawing you have ſeen, which is taken from a plant dug out of a mead, by the ſide of the river Wear, that is richly ſtocked with them by the hand of Nature.

I MUST alſo apprize you, *Agricola*, that the propereſt ſeaſon to ſow burnet is in autumn; for if ſown in ſpring, it hardly comes until next ſpring. Burnet, like other herbage deſigned for hay, ſhould be mown before the ſeeds are compleated; and as the leaves are thin and apt to bruſh off when much dried, it ſhould be as quickly handled as poſſible, and as ſoon as it is dry enough, ſtacked or lofted.

IN our next converſation, *Agricola*, if you think proper, we ſhall firſt diſcuſs the culture and uſe of red clover.

Agric. SHALL be much obliged to you, Sir.

CON-

CONVERSATION XVII.

PHILOSOPHUS.

AT the concluſion of our converſation laſt night, I remember it was agreed upon, to attend to the culture and uſe of red clover, at our next meeting; and I have been preparing accordingly: And to put you on your guard with reſpect to its uſefulneſs, I muſt tell you, without at all prefacing the matter, that it is, in the hands of judicious huſbandmen, an invaluable plant; but in the hands of imprudent proprietors and deſigning tenants, a moſt deſtructive inſtrument.

Agric. SHOULD be glad to know how it proves ſo detrimental to ſome, and ſo beneficial to others, Sir.

Phil. THAT will appear by and by, *Agricola*: Know then, that red or broad clover is a biennial plant, which, like all other ſhort-lived beings, is exceedingly eager to propagate its ſpecies; and conſequently, if ſuffered to arrive at maturity, bears a large quantity of ſeed, in which is contained a great deal of oil and fixed air, the moſt of which is undoubtedly collected from the ſoil. And I believe I need not repeat to you, *Agricola*, the ſcarcity and neceſſity moſt ſoils have of thoſe ingredients. Hence, if a tenant is under no leaſe, or rather if he does not know the bad effects that will obtain,

tain, and frequently puts his land under red clover, and mows it twice a year, as is uſual: And ſuppoſe he lets it ſtand only until it is in flower, as the flowers themſelves contain large portions of volatile ſalts and eſſential oils; conſquently, if I may uſe the expreſſion, they threſh the ſoils moſt conſummately. But to be more explicit on this important ſubject, we ſhall take a view of the courſe too commonly adopted in clover huſbandry.

FIRST, the field is ſown with wheat in autumn, and in the ſpring with red clover, otherwiſe with barley and clover in the ſpring: Next year the clover is twice mown; and the year following, the ſame; then it is eat bare; in the autumn, plowed up and ſown with wheat; after the wheat, a fallow with turnips; and then barley and red clover to begin the courſe again.

AFTER three or four times repeating this courſe, the field is ſown down to lie for graſs, with eight or nine pounds of red clover, and ſeven or eight buſhels of hay ſeeds, to every acre.—The reſult is, the firſt and ſecond years, if the land has any pabulum left in it, there is a tolerable ſhear of graſs, which in general they mow twice a year. The third year, no clover, and very little graſs; the next year leſs; and the longer the worſe: Upon which, application is made to the landlord or ſteward, for leave to take up the field again; for ſuch crops of graſs as it now turns up, forebodes inevitable deſtruction.—A view, no doubt, is taken by the ſteward, and up it muſt be, as there is no readier method for reclaiming it. However, in-

ſtead of ſetting about that neceſſary work immediately with a good fallow, the land is ſown with oats. Sometimes I have ſeen the farmer ſo unconſcionable, and the ſteward ſo inconſiderate, as to put it under wheat and oats after, before it gets a fallow, or any ſupply of dreſſing, to the utter ruin of the ſtaple; unleſs it can be dreſſed with plenty of black dung, or ſome of the eſſential manures.

Agric. I HAVE ſeen too many inſtances of this beggarly huſbandry, to diſpute the juſtice of your concluſion; and do moſt ſincerely rebrobate ſuch a courſe, becauſe it has an immediate tendency to injure the proprietor, if perſiſted in; who, I think, has as good a right to have his land yielded up to him at the expiration of the term it was hired out for, in good condition, as a perſon that lends money upon intereſt, has to have his ſum returned in ſufficient tale and coin.

Phil. YOUR liberal way of thinking, *Agricola*, pleaſes me much; but mind, take this with you, that if a proprietor of land hire his land out at an unreaſonable price, the tenant has as good a right to take all the advantages his bargain entitles him to, as a borrower of money has to take advantage of the act of parliament, made to puniſh thoſe lenders of money who take exorbitant intereſt:—But this by the bye.

IT would be miſſpending time, *Agricola*, to inſiſt farther on the impropriety of the above courſe; as you well know it exhauſts, or ſurfeits (as ſome people term it) even good ſoils in a very

very few rotations: Shall therefore proceed to ſhew its moſt profitable uſes and conſiſtency to good huſbandry.

AND with reſpect to the former, I have not ſeen it, or any artificial graſs, turn to better account than it does in green feed for horſes; as it fattens them amazingly, yields a great deal of dung if the ſtable is kept properly littered, and ſupports a large ſtint; leſs than half an acre, if it is a tolerable crop, being ſufficient to keep a horſe from the beginning of *June* to the end of *October*. It is alſo a beneficial graſs both for hay and after-math, provided only once mown in one year, and the after-math or fog fed down with horſes, ſwine, ſheep, or young cattle: But the precautions I have mentioned (page 178) to prevent hoving, muſt be ſtrictly attended to, if cattle are introduced.

I ALSO am of opinion that it would turn to good account in being uſed as green feed for oxen or other cattle intended for fattening, when cut and carried to their ſtalls, provided the abovementioned precautions are attended to, until the creatures are inured to the feed.

IT remains now to ſay how far it may be cultivated for theſe purpoſes, without injuring the ſoil, or conſiſtent to good huſbandry, as I juſt now expreſſed it; and this, I preſume, may be done as follows, viz.

FIRST, If the clover is chiefly intended for green feed, the vicinity of the field to the ſtalls is a circumſtance to be attended to, for it will ſuffer much in long carriage, and the labour will of itſelf be a drawback on the amount.

SECONDLY, Before land is put under clover for the above purpoſes, it ought to be made a complete clear fallow, and receive a plentiful dreſſing of black dung in the ſpring, a little before the barley and clover ſeeds are ſown; twelve pounds of the latter and three buſhels of the former is a ſufficient quantity per acre for broad-caſt huſbandry; which, I think, preferable to the drill huſbandry in the culture of red clover.

CARE ought to be taken that the ſeeds are good* and the barley of the ſpecies that is not apt to lodge or lie.† Indeed if the farmer or proprietor could be prevailed on to ſow the clover in the ſummer ſeaſon, as directed in page 183, &c. without corn, he would, I doubt not, reap as much advantage; but either way will anſwer to good account, provided the preparation is pertinent.

NOW, *Agricola*, as the trifolium *protenſe* or red clover, holds its vigour only two years, it is an intimation ſufficient for you and

* THE beſt red clover ſeed is large, plump, and ſhining, and of a purple colour. It is beſt to defer the ſowing clover, until the barley is two or three inches high, and then roll it in with a bruſh'd roller, *i. e.* a roller with a bruſh affixed to it.

† THIS barley is by ſome called prick barley, by others French barley, and by others ſprat barley; and by ſome battledore barley.

and every rational cultivator of it, to hold it no longer without a freſh ſowing; and therefore, if you mean to have your horſes, &c. kept, or fattened yearly and every year, by this ſort of feed, you muſt have one field ready to break into, when the preceding one goes off.

Agric. Undoubtedly, Sir, but your directions concerning the management of the fields after the clover can be no more cut, will be very acceptable.

Phil. IF the fields are in good heart, it will not be improper to plow up the clover ſtubble, and ſow the land with wheat; after the wheat, make a good fallow, and either begin the courſe or not as circumſtances require.

RED clover may alſo be raiſed to anſwer either for green feed or hay, without injuring the land in another mode or courſe, viz. in lieu of oats, where wheat and oats are taken to a fallow. The clover in this way is to be ſown in the ſpring of the year amongſt the wheat leaves, and covered in with cloſe, ſhort tinned harrows, and next ſummer either mown in lots for green feed, or in larger portions for hay. The aftermath or fog proves of great ſervice to the farmer's ſtock; and if he is not one of thoſe who want to reap where he did not ſow, but on the other hand labours and dreſſes his land to purpoſe, were I his landlord, I ſhould not ſcruple to let him ſow the clover ſtubble, after it had been fed off and properly

plow-

plowed, with wheat: By this means the farmer would reap three crops to a fallow, and each of them as good, probably better, than the crops of the two crop courſe, without injuring the land.

BESIDES theſe, there are a few more plants that are denominated artificial graſſes, viz. the white Dutch clover,* hop clover, ſpurry, &c. &c. The two firſt I have already deſcribed, and given an account of their uſes; and the laſt is not of ſufficient conſideration to merit a particular deſcription.

THERE remain yet a great variety of articles in the ſcience of huſbandry, *Agricola*; ſuch as hops, liquorice, madder, ſaffron, woad, weld, hemp, flax, &c. &c. &c. the cultivation of which we have not attended to: But as you intend to make the tour of *Britain*, that, together with ſtudying the works of *Philip Miller*, F. R. S. and *Arthur Young*, Eſq; or other good authors, that treat on thoſe matters, you will attain a competent knowledge of them: So ſhall proceed to explain briefly the rationale of planting, making, and ordering of fences; and conclude this part of our plan for the inſtruction of youth and others

* WHEN land is intended for ſheep walks, there cannot be a better ſeed for it than white clover, as it is both a rich and ſound graſs; and when ſown to the amount of eight pounds, and eight buſhels of good hay ſeeds to an acre, there will be a cloſe and durable ſward. It is alſo the beſt plant a gentleman can ſtock his lawn with, to make it ſightly and eaſily kept. Whether mown or fed down with ſheep for this uſe, ſow from ſixteen to twenty pounds (according to the moiſture of the ſeaſon) per acre, and let it be ſown before the middle of *May*, otherwiſe defer it till *Auguſt*.

others engaged in the ſcience of huſbandry, with a ſmall addenda of obſervations and theory, that have been omitted, or not treated of in the courſe of this work.

Agric. SIR, when I conſider how particular you have been in explaining the principal matters peculiar to the theory of the ſcience, and alſo your aſſiduity and care in recurring to practice, when at all neceſſary, I cannot but conclude, that what you have now propoſed, will fully anſwer the purpoſe, and more than you engaged for, as well as my moſt ſanguine expectations.

Phil. PHILOSOPHERS hardly know what to make of gentlemen's ſpeeches when they abound with commendation: However, now I recollect, that a great deal of *Agricola*'s time of late has been ſpent with the fair ſex, I ſhall take his to be ſincere, although rather too ſweet, and proceed with the rationale of planting, making, and ordering fences, as propoſed.

FIRST, then, whether the plant (which is intended to be raiſed) be for ornament, timber, or fence, let the fruit be taken from a healthy ſubject: Let it alſo be well ripened and carefully preſerved* until it is committed to the earth or matrix; and even then let care be taken that the ſoil is of itſelf freſh, ſtrong, and healthy, not an old worn out piece, patched up with dung or compoſt; for this is like making up an old ja-

* IN particular, let them be kept from ſcorching heats, and moulding damps; as the firſt diſſipate the oils, and the other furniſh a conductor to bear away the moſt eſſential rudiments of the plant.

jaded animal, and putting it to breed; which, if it do conceive, never brings forth that which is healthy and vigourous, but a creature big with deformity, ſores, or liſtleſsneſs.†

CARE muſt alſo be taken that the fruit be not depoſited at too great a depth, that is below the line of the ſtaple or beſt ſoils; and that the degree of heat in which the bed or tub is ſituated, be ſimilar to the degree of heat, or nearly ſo, peculiar to the place from whence the fruit was gathered.

WHEN the plants are fit for tranſplanting, let all imaginable care be taken to preſerve the bark; and if they are ſhy to ſtrike, their ſmall fibrous roots muſt be preſerved. Theſe ſhy growers, however, ought not to be often tranſplanted; and their laſt reſidence ought to be a virgin ſoil. Plants that are apt to grow, get more roots by being tranſplanted, provided the planter underſtands pruning their old roots; the criterion of which is to cut near to, but without the greateſt number of eyes, as from thoſe eyes proceed numerous ramifications of abſorbents.

THE beſt ſeaſon for planting is in *November*, *December*, *January*, and *February*; becauſe in thoſe months, moſt plants are in a dormant ſtate, and meet with little or no check by being tranſplanted; provided the weather be freſh, and care be taken to make their new habitation at leaſt as comfortable as that they were

† ACCORDING to this principle, old gardens are exceedingly unfit for nurſeries, and ſo experience announces them.

were taken from: To do which, the quality of the ſoil, the ſituation, climate, and expoſure, are ſtrictly to be attended to. It is alſo very neceſſary to mark the plants before they are taken up, eſpecially if old, on the ſide next the ſun at mid-day, with a piece of red chalk, and put the mark to the ſame point when they are planted again; otherwiſe there will be odds againſt the planter, that he puts the largeſt pores of the tree (which are always on the ſouth ſide) to the moſt languid circulation, which will much impede the growth of the plant. Care muſt alſo be taken to ſtretch at full length the whole aſſemblage of roots, when the plant is put in the pit: For if they are left wreathed up, it is like gagging an animal before it is ſet to feed. It is alſo neceſſary to ſtrew fine mould below, and amongſt the roots, as well as over them, and to preſs it down to the conſiſtence of unbroke earth, after they have been ſprinkled with water.

AFTER this is performed, and a piece of long muck, ſawduſt, or ſome ſuch thing laid over the pit, to prevent froſt getting at the roots of the plant; it will be neceſſary, if the plants are not exceedingly cloſe together, and well ſheltered, to ſupport them with ſtakes for twelve months at leaſt. In doing this, great care muſt be taken that the feet of the ſtakes do not interfere with the roots of the plants: and that the guys or ſtays be connected with the plant at two places at leaſt, viz. where the lowermoſt branch is. This may be done, if even full grown trees,* by putting up three poſts in a trian-

* THE beſt machine I have ſeen for taking up trees with a ball, and carrying them to new pits, is a cart invented by Mr *Jones*, late gardener to the Earl of *Darlington*.

gular manner, and ſo extended at bottom as to make them lean to the tree, at their top, in an angle of thirty or forty degrees; and nailing battens from poſt to poſt, at two or three places near the top, to keep them in the above poſition: and if two of the poſts are put in that ſide of the tree oppoſite to the point the greateſt guſts of wind blow from, it will give the frame great advantage. After the frame is let into the ground at bottom, and ſecured as above directed, the ſpace between the tree and the battens that are nailed from poſt to poſt, at the top of the frame,* ſhould be crammed full of the ſtalks of ſmall ling, birch twigs, or ſomething that will not injure the bark; and at the ſame time allow the water that falls upon it to paſs freely down, which hay, altho' greatly uſed for that purpoſe, is incapable of doing, and thereby rots the bark of the trees; conſequently the tree is ruined.†

IT will alſo be a great advantage to the tree, eſpecially if it is tall and ſlim, to have ſtays extended from poſt to poſt of the frame, about half way between the ſurface of the ground and the top of the frame, and ſo contrived as to circumſcribe the tree, and made to receive a few twigs, as above directed; which will, as it is at or near the center of percuſſion, effectually prevent a ſhake either at the root of the tree, or where the ſtays graſp it.

THESE

* THESE battens ought to be put to the inſides of the poſts, and ought alſo to be eight or nine inches broad, and ſufficiently ſtrong to bear the ſhake of the tree.

† THE twigs may be bound together with rope yarn, to prevent their dropping out.

THESE are but common things, *Agricola*; but yet they have a theory to direct them, you ſee; and when a planter goes by random, notwithſtanding he may be very induſtrious and very clever, he may err even in ſtaying a tree.

Agric. THERE can be no doubt of it, Sir; but is there not a neceſſity for pruning the branches of trees, of all ages and kinds, when they are tranſplanted?

Phil. FROM its being ſo much practiſed, it is natural to think there is a neceſſity for it, *Agricola*. But when we look for a reaſon or theory for ſo doing, there ſeems no great neceſſity for the practice; eſpecially when it is done indiſcriminately: Becauſe the points of the branches, if they are healthy, receive that enlivening principle which the atmoſphere poſſeſſes, in conjunction with the roots; by which means, a balance in that eſſential power commences; and conſequently a degree of heat that excites a diſtribution of the juices immediately, if the ſeaſon is mild. Whereas, if the branches are pruned, that balance is deſtroyed; and the growth of the tree thereby retarded, until the heat of the ſun ſupplies the deficiency, if the deficiency can at all be made up: For if the conducting matter in the roots corrupt for want of action, the tree will ſurely ſuffer by it, altho' it may not appear at that ſeaſon.

IT, therefore, ſeems to be more eligible to plant without pruning the branches, except thoſe that are decayed, until the decline of ſummer, and then execute the work.

Agric. Delaying the pruning till the decline of ſummer, I think, can be no inconvenience indeed, Sir; but does pruning, even at the proper ſeaſon, much facilitate the growth of the tree?

Phil. Yes, that it does, *Agricola*, if judiciouſly performed; and there is very little more to be obſerved concerning the operation, than ſloping the cut upwards, with a ſharp tool, taking care not to move the roots:—and if a foreſt tree, pruning pretty cloſe to the bark, and leaving a ſufficient number of thoſe branches that are clean and erect, but particularly the leaders. *If a fir, prune not at all, becauſe the wounds exhauſt the tree very much by letting out the ſap. Indeed, Nature declares it unneceſſary to be done by man, as ſhe does it herſelf as often as neceſſary, by a decay of the under branches: All that is therefore left for man to do on this occaſion, is to cut the withered boughs cloſe to the bark, which will prevent their perforating the timber.

THE next eſſential particular in planting, is to give the plants air, and free them from the drop of other plants or trees, and to keep graſs or weeds from robbing them of the food the ground they are planted on contains; and from rot-

*THERE is no better rule to determine the number of branches that are to be left to draw the ſap, and to anſwer the other uſes of vegetation, than having reſpect to the number the tree has naturally, and leave in that ratio: And as it is better to leave too many than too few, becauſe they may be cut another year, I ſhould not adviſe to take above one-eighth of the whole at firſt.

rotting their bark, &c. There are ſeveral other things relative to planting, *Agricola*, yet undiſcuſſed: but as they are already well underſtood, there ſeems no neceſſity to call them up: So ſhall proceed to deſcribe ſome effectual live fences, and the way to raiſe and maintain them at a moderate expence.

AND of all others, I think, the white thorn and holly, eſpecially the former, deſerve the preference. And the moſt ſucceſsful method of raiſing, is from the quick, in the following manner, viz. let it be at leaſt three years old, deſcended from large, perfect fruit, and ſprung in good, freſh ſoil: Being thus ſerved with plants, if the land on which the hedge is to be made, is dry and deep of ſoil, pare off the ſward as deep as the graſs roots, (that is, the crown roots) directly under the line you intend to lay your quicks in, and ſlope the remaining ſoil for about ſix inches deep, in an angle of 45 degrees* or thereabouts. The ſlope of the trench will be then about nine inches; and if it is all in good ſoil, nothing more is neceſſary to be done, until the quicks are laid in it. If it is poor land, the trench ought to be ſtrewed with good mould, if it is to be had: The roots of the quicks are now to be pruned, and the ſtems cut through with a ſharp knife, in a ſloping direction, at about three inches above where the upper roots proceed: and then they are to be laid on the ſloping trench with their heads half

* THE ſlope is to be regulated by the wet or dryneſs of the ſituation, as in the latter they may be laid at a leſs angle than when it is wet.

half an inch out of the cover, and about ſix inches apart: then the roots are to be carefully ſpread, and covered with good ſoil, well pulveriſed, and thruſt in among them. But if fine ſoil cannot be had conveniently, a thin covering of the beſt ſoil that the place affords muſt be uſed, and a layer of black dung laid over it, and then the mound or pile, which is to be raiſed upon the quicks ſo planted, is to be completed with the contents of the trench, that is dug before them, in order to drain off water, and give the ſhoots air. If this trench be three feet wide at top, and two feet deep, ſloping on each ſide, ſo as to make it about eight inches wide at bottom, and the contents ſo thrown out, kept to about three feet wide at bottom, and ſloped pretty much from the head of the quick, and held near perpendicular on the other ſide, the mound will be about two feet high, which is ſufficient if rails or hurdles are to be put behind or upon it, to prevent cattle and ſheep from cropping the ſhoots: They will, if thus managed and kept clean, in four or five years, be an effectual fence.

IF the land on which the hedge is to be raiſed, is thin and inclinable to wet, inſtead of ſinking a ſloping trench for the bed of the quick, place a ſod upon the ſurface of the ground where the quicks are to be laid, and ſlope the back of it for the reception of the quick; and in every other reſpect proceed as above directed. If it is in your power to regard choice, with reſpect to the ſide of the mound or bank you lay the quick under, you'll find the eaſt and north ſides are the beſt, becauſe the ſun does not ſo much affect the roots while they

are

are tender on thoſe ſides of a mound, as on the ſouth and weſt ſides of it: Neither do falls of ſnow load, and conſequently break, the ſhoots ſo much, when planted on the eaſt or north ſide, as when on the oppoſite ſides. The reaſon of which, I dare ſay, you clearly perceive, is, becauſe ſnow generally comes from the north or eaſt quarters, and is thence driven through the hedge before it lodges.

Agric. I PERFECTLY underſtand the directions, Sir; but would be glad to know why you lay the quicks ſloping, as all trees incline to an erect poſition?

Phil. IT is, becauſe the roots of the quicks are leſs diſtreſſed in that direction, than when they are ſet erect, and can diverge more eaſily in an horizontal direction, which is the propereſt, as the beſt ſoil then environs them.

Agric. THESE are good reaſons, Sir; but beſides theſe, there is another, I think, no leſs intereſting, viz. the abatement of the weight of the juices; for altho' the tranſuding principle may not be effected by gravity, I cannot ſuppoſe the material food of the plant is alſo exempt therefrom: And the improvement I have obſerved in old fruit trees, by being laid ſloping, as you formerly explained, is a full demonſtration that the branches or ſhoots will be more amply ſupplied when the quicks are laid in a ſloping than erect poſition.

Phil. I am obliged to you for thus reminding me of the above, as it is full as pertinent here as in any caſe whatever.

But

But you are to remember, that as the ſhoots grow in a perpendicular or erect direction, and the quicks from whence they ſpring lie in an oblique one, that they will be apt to ſink with their heads, eſpecially if the ſide of the drain below them moulders down. It will be neceſſary, therefore, in the ſecond autumn of ſpring after they have been planted, to breaſt up that ſide of the drain with ſod, or ſtone and ſod, as high as the end of the quicks, which greatly promotes their growth and ſecurity. It will likewiſe be an advantage to them, if the lateral twigs are pruned with ſhears every year, about Midſummer; but remember not to prune the leaders, or upright ſhoots, until they are ſeven or eight years old at leaſt.

AFTER that period, if dead wood is wanted for fuel, making fences, or any other purpoſe, you may cut your hedge at about two feet above ground, taking care to ſlope the cut upwards, and that it be done juſt before the ſap begins to move, if poſſible; and alſo that the ſtocks be well ſecured from ſheep, cattle, aſſes, &c. and that freſh mould be thrown to the old ſtocks, the ditches ſcoured, &c.

FROM this treatment, the ſhoots will in three years be both fence and ſhelter, and ſo will continue for many years. However, if you want dead wood again, or if they turn moſſy on the ſtems or branches, you'll do well to cut them again; but cut them then at one foot above the ground. The next time you have occaſion to cut, let it be done at about two feet from the ground; and next time

time cloſe to the ground; then at two feet above the ground, which begins the courſe again: By which treatment a hedge of white thorn may be cut and ſprung, *ad infinitum*, affording all the while both profit and pleaſure.

IT will, however, be proper to obſerve, that in caſe you uſe dead wood to fence them while young, that it be placed at a diſtance from the ſhoots: For if the drop from it, or the bark of it, touch the ſhoots, it will be a great detriment to them: And if there is occaſion to plaſh a white thorn hedge, it is infinitely better to lop off the twigs, and twiſt the ſhoot that is to be laid at the place it is to be bent at, than to gaſh it nine-tenths through with an axe at that place, as is uſually done: For when the ſhoots ſpring to a good ſize, the winds tear the original layer from the ſtock, at the place where it was ſo gaſhed. Hence, we often ſee half a rood of hedge tumble down at a time. The ſame principle holds good with reſpect to plaſhing any other hedge wood.

YOU will alſo be careful, *Agricola*, to avoid the abſurd practice of planting trees in hedge-rows. I proteſt I never ſee it done, but it calls to my mind the dog in the fable, that loſt the ſubſtance by ſnatching at the ſhadow.

THE next article, *Agricola*, relative to fences, that preſents itſelf to us, is their direction, and the ſhelter they afford: And as the latter greatly depends upon the former, we are to attend particularly thereto, which we will do in the next Converſation; for the preſent, I believe, you will readily excuſe me.

CONVERSATION XVIII.

PHILOSOPHUS.

LAST night, when we broke up, *Agricola*, it was propoſed, that at our next meeting we ſhould take into conſideration the beſt direction of fences, reſpecting ſhelter, &c.

AND as the benefit reſulting from the moſt proper direction of fences, is breaking off the cold ſpring winds, the ſhedding winds about the autumnal equinox, &c. We muſt attend particularly to the points from whence theſe annoyances proceed, which, in a general way, we may fix the former at North-Eaſt, and the latter at South-Weſt in this iſland.

Agric. THESE, Sir, are the points, or nearly ſo, that we have the ſevereſt attacks from: But why it is ſo, and why you ſay on this iſland, I own I am very curious to know.

Phil. I AM very unwilling, *Agricola*, to refuſe you any gratification in my power: Shall therefore give you my opinion on the matter as briefly as I can.

KNOW

KNOW then, *Agricola*, that winds are occaſioned by any conſiderable change of denſity or rarefaction in the atmoſphere; and as the places on the other ſide of the *German* ocean, north-eaſt of us, viz. *Denmark*, *Sweden*, and part of the great empire of *Ruſſia*, &c. have commonly ſuch exceeding hot ſummers, altho' but ſhort, that the atmoſphere over them becomes ſo much rarefied, that when their ſummer begins to decline, which is by the end of *Auguſt*, and the rarefaction conſequently ceaſes, the atmoſphere ruſhes in from all quarters, to make an equilibrium.

AND if the heat of the ſummer there has been very intenſe, and a ſudden change to cold, which is commonly the caſe, for they have no autumn, the winds will have exceeding great force, eſpecially if the ſummer with us has been wet and cold.

Agric. FROM this account it ſeems as if it might be foretold when we would have high winds at that ſeaſon; becauſe if it depends principally upon the heat of the ſummer in thoſe places, it is poſſible to learn ſufficient particulars concerning that to lead to an inveſtigation.

Phil. IN the year 1773, we had frequent accounts of the ſevere drought and ſultry heat in thoſe countries; and, I believe, you have not yet forgotten what followed, as we had for two weeks in *September*, prodigious guſts of wind, and much loſs of corn in conſequence thereof.

So far the theory is confirmed, *Agricola*; and if you'll take notice in future, I preſume you'll meet with ſufficient teſtimony of it: And alſo that the north-eaſt winds (or piners, as they are called in the north of *England*) which we have in *April*, &c. are occaſioned by the ſetting in of their ſummer (for ſpring they have none) as the rarefaction in their atmoſphere will drive the condenſed air upon their neighbours: Hence it is they have north winds in *Germany*, *Poland*, &c. in that ſeaſon; and ſouth winds in *September*; becauſe they lie ſouth of thoſe places that have ſuch ſultry ſummers and extreme cold winters, and know not the happy mediums of ſpring and autumn, which the adorable author of nature has bleſſed us with in this temperate iſland.

Agric. I SEE the reaſon very clearly, Sir, why we have ſouth-weſt winds in this iſland at the autumnal equinox, and alſo why we have north-eaſters in *April*, *May*, &c. but I do not underſtand whence it is we have ſo much ſtormy weather in winter, with the wind at north and eaſt, and the adjacent points.

Phil. THE moſt material reaſon that can be given for the phænomena, *Agricola*, is the inequality in the ſize of the two ſeas that bound this iſland; for as the ſeas are environed with warmer vapours than the land in winter, the largeſt ſea will have the cold clouds travelling towards it, in order to reduce every part to an equilibrium; for the heat is not ſo great, as to prevent them by rarefaction, as was the caſe in the eaſtern pro-

provinces, we formerly mentioned, in their ſummer. And as the *Atlantic* or weſtern ocean is infinitely larger than the *German* ocean, if the above theory is juſt, we muſt have our cold weather from the north and eaſt, and the adjacent points: But mind, *Agricola*, this general cauſe is modified by ſeveral particulars, and conſequently liable to exceptions, which I cannot undertake to mention at this time.

FROM what has been above premiſed, it appears pretty clear, that in order to receive the moſt ſhelter from hedges, they ſhould be laid to break the force of the autumnal wind, and prevent the ſeverity of the winter ſtorms as much as poſſible; and at the ſame time admit the ſun-beams to have their full effect upon the incloſures.

NOW, as a hedge neither affords the moſt ſhelter when the wind ſtrikes it at right angles, nor ſuſtains the ſtorm with ſo little injury to itſelf, as when it lies at an angle thereto; it muſt be proper to give the preference to the latter poſition. Hence, if we take ſouth-weſt, north-weſt, ſouth-eaſt, and north-eaſt, to be the principal points againſt which we are to fence, we ſhould lay our hedges in the four cardinal points, viz. the north and ſouth hedges to point eaſt and weſt: and the eaſt and weſt hedges to point north and ſouth. This gives them the greateſt chance to reſiſt the wind, as it then muſt ſtrike them diagonally: It alſo anſwers beſt for the admiſſion of the ſun-beams.

THE next thing to be conſidered with reſpect to incloſures, *Agricola*, is their ſize, ſituation, and figure: As to the firſt, the bet-

better the land (if there is no particular reaſon for doing otherwiſe) the larger the fields may be admitted; eſpecially if they face or hang to the ſouth: But land that faces the north, requires to be made into fields conſiderably ſmaller. For inſtance, land facing the ſouth will as well admit to be laid into 20 acre fields, as land that faces the north will admit being laid in fields of 8 acres: And with reſpect to the figure of fields that face the north, if it is poſſible, they ſhould be oblongs, the greateſt length eaſt and weſt; and always the ſteeper the hang, the narrower the field. The reaſon of which, and what remains concerning hedges, I am well aſſured you are perfectly acquainted with. It would therefore be next to mis-ſpending your time, to dwell longer on this ſubject: So ſhall proceed to ſhew you my method of eſtimating the value of land, whether in tillage or graſs.

Agric. SHALL be much obliged to you, Sir: But it is not in our power to hire a farm at our valuation: That is always in the breaſt of the landlord or ſteward.

Phil. YOU have half of the bargain in your option, *Agricola*; and why ſhould not the landlord have the other half. I ſuppoſe you would think it hard when you go to market to ſell your commodities, if you had not a right to aſk as well as the buyer had to bid a price.

Agric. I THINK the caſes are not ſimilar, Sir; for we that have ſtock and utenſils fitting for farms, and know no other employment, cannot be without farms.

Phil.

Phil. AND thoſe who come to buy your commodities have demands that cannot be ſuſpended. But this is only talk; there is a criterion; and, I think, from what follows, you will clearly ſee it, *Agricola*. The firſt thing a perſon who goes to hire a farm ſhould do, is to deſire to peruſe a copy of the courſe of huſbandry that is to be indorſed upon the leaſe.

Agric. YOU ſpeak now as if the bargain was made, Sir: how can there be a courſe of huſbandry before the agreement is concluded?

Phil. EVERY regular ſteward, before he treats about letting a farm, will have the courſe of huſbandry made out, and rent ſettled; otherwiſe he is like a ſhopman that has to run to his bill of parcels before he can aſk a price. I therefore conclude, *Agricola*, your ſurpriſe proceeds from its not being cuſtomary with you to tranſact ſuch buſineſs by method, but to ſit higgling a whole day over a bargain, in order to fatigue the letter into a compliance.

INDEED I would have every perſon that hires a farm, to conſider well the particulars relative thereto; and alſo the ſteward that lets it. Hence, if they are both judges of the matter, and want to deal fairly, two words are as competent to a bargain as two thouſand.

Agric. AND muſt we comply with every thing they dictate?

Phil.

Phil. OTHERWISE not get the farm, *Agricola*: Nor do I think it any thing out of the courſe of buſineſs. If you let your cart to carry goods to any perſon, I believe you mind to aſk how far it is to go in a day, and what weight the goods are, in order to prevent your cattle from being oppreſſed; and certainly a proprietor of land has an equal right to ſecure his property from diſtreſs. But I know it is contrary to your principles to injure the landlord; ſo it is a dread of the want of ability in the ſteward, I ſuppoſe, you are looking to. However, if you can ſubmit to method, you'll ſoon diſcover whether the ſteward knows his buſineſs or not; and alſo whether you ought to take or reject the farm: For take it I would not, unleſs I ſaw a proſpect to make it pay.

Agric. I SHALL be much obliged to you, Sir, for a direction in that buſineſs.

Phil. AND what I would have you to do, is as follows:

FIRST, with reſpect to the corn you ſhall raiſe, inform yourſelf whether the land produces it of good quality.

SECOND, What an acre of the land in the farm, which you have a right to crop, will produce. This is a very material point, and ſhould be carefully decided: And as the ability of determining judiciouſly in this matter, is acquired chiefly by practice, it is proper farmers and ſtewards ſhould reckon the ſheaves an acre of corn produces of a great variety of crops, and at different times; and alſo meaſure the produce of

of a given number of ſheaves: Whence, as a butcher, who by frequently weighing carcaſes and ſtrict compariſon, acquires a critical nicety in determining the weight of carcaſes, they may come very near the mark: And that they may be able to exerciſe their ſkill with preciſion, farms ſhould be viewed either a little before the corn is harveſted, or before the crop is carried. It ſhould alſo be obſerved, whether the crop is uncommonly good or otherwiſe, and that accidents ſhould be provided againſt.

THIRD, What it is worth at market per quarter. This is alſo a point of great importance, and what, after the utmoſt care, a perſon may err in: But the greateſt probability of ſucceeding properly, is, to take the average price that ſuch grain has brought at that market for a term of years back, ſimilar to the leaſe you mean to take.

FOURTH, Upon the ſame principles, eſtimate the produce of your other ſpecies of grain.

FIFTH, Compute, impartially, the value of your graſs land: And this is to be done by properly conſidering what quantity, and kind of ſtock will turn to the beſt account, (*cæteris paribus*). In the inveſtigation of which, it muſt not be omitted, to have reſpect to the ſituation of the place, as well as quality of the ſoil; for near great towns milk is of vaſt conſequence: Whereas, at a great diſtance from them, breeding ſtock may anſwer a better account than milk, if the land is of inferior quality; or if rich, fatting or hay will beſt anſwer the purpoſe. In this

deciſion very much depends; and nothing ſhews the huſbandman's abilities more conſpicuouſly, than a ſuitable arrangement of his ſtock and crop. And let me, by the bye, be permitted, *Agricola*, to warn all your fraternity againſt contracting for greater farms than their capital anſwers to: For if they do, they can neither ſtock properly, nor ſell properly, unleſs by accident: Conſequently, the farm will be blamed for ſhort comings, that have their origin in the want of capital, and diſcretion in the occupier.

SIXTH, Attend to the number and kind of ſtock that may be kept about the homeſtead, ſuch as ſows, pigs, poultry, &c.

SEVENTH, Attend alſo to the number and kind of winter-ſtock, for eating ſtraw in the farm-yard, &c.

EIGHTH, Enquire into the expence of keeping the poor, and all ceſſes.

NINTH, Compute the expence of ſervants to labour the farm, and keep the fences.

TENTH, The expence of ſeed-corn of every kind uſed in ditto.

ELEVENTH, Ditto of harveſting corn and hay.

TWELFTH, Ditto of threſhing and winnowing.

THIRTEENTH, Ditto of marketing crop and ſtock.

FOURTEENTH, Ditto of manure.

FIFTEENTH, Ditto of wood, to anſwer repair of utenſils.

SIXTEENTH, The expence of carpenter work.

SEVENTEENTH, Ditto of ſmith work and iron.

EIGHTEENTH, Ditto of highway duty.

NINETEENTH, Ditto of looking or weeding your crop.

TWENTIETH, Ditto of ſcaling and ſtoning the graſs land, deſtroying moles, and other vermin.

TWENTY-FIRST, Ditto of hoeing any crop that needs it.

TWENTY-SECOND, Ditto of weeding the graſs land.

TWENTY-THIRD, Ditto of draining, where neceſſary.

TWENTY-FOURTH, Ditto of ſhearing ſheep, and marketing the wool.

TWENTY-FIFTH, Ditto of ſalving ditto, if neceſſary.

TWENTY-SIXTH, Ditto of bull, ſtone-horſe, boar, and rams.

TWENTY-SEVENTH, Ditto of paring and burning land, where neceſſary.

TWENTY-EIGHTH, Ditto of tyth, if it pays any.

TWENTY-NINTH, The amount of intereſt on the money employed in the farm, at 10 *per cent.*

THIRTIETH, The wages of the farmer, for attendance and giving directions: But mind, *Agricola*, this ought to be apportioned with propriety; for altho' ſome farmers may deſerve to be rewarded as artiſts, yet there are ſome that hardly deſerve to be paid as labourers: Nor ought the ſame ſum to be allowed for a ſmall farm, as a large one.

Agric. I SUSPECT this will be a tedious buſineſs, Sir; as you are already within nine of as many articles as there are in our religion.

Phil.

Phil. AND if there were as many more, *Agricola*, it is your duty as a farmer, to ſubſcribe to them all, rather than appear in the ridiculous manner you do, when you take a farm without any other data than knowing the old rent.

Agric. WE alſo, at leaſt, inform ourſelves how the late farmer ſucceeded, Sir: However, I beg you will go on, for I have no objections to the method for my own part.

Phil. I INTEND to proceed, *Agricola*, notwithſtanding your punning; becauſe I ſincerely believe, you broke ſilence only for that purpoſe; as it is with you, as with moſt gentlemen addicted to that humour, neither friends nor religion are exempt, when an opportunity offers. But I proceed; and having ſhewn what you are to take under conſideration, ſhall preſent you with a ſcheme or courſe of huſbandry, that is to be indorſed upon a leaſe, for nine years, of the farm called *Thrivewell*, which you are very well acquainted with; and likewiſe a draught of the leaſe.

THESE you may peruſe at your leiſure, *Agricola*; and when we meet again, by way of praxis, I'll ſtand letter, and you taker.

A COURSE of HUSBANDRY,
For NINE YEARS.

Names of Fields.	Quantity. A. R. P.	1774	1775	1776	1777	1778	1779	1780	1781	1782
Summers	21 3 0	wheat	⅓ peaſe ⅓ oats ⅓ clover	⅓ clover fallow ⅔	wheat	⅓ clover ⅓ peaſe ⅓ oats	fallow	wheat	⅓ beans ⅓ oats. ⅓ clover	fallow
Plains	10 2 16	paſture	hay	paſture	hay	paſture	hay	paſture	hay	paſture
Lows	10 0 0	paſture	hay	paſture	hay	paſture	hay	paſture	hay	ditto
Downs	120 0 0	ſheep walk	ditto	ditto	ditto	ditto	ditto	ditto	ditto	ditto
Standers	21 0 0	allo w	wheat and gr. ſeeds	hay	paſture	hay	paſture	hay	paſture	hay
Flatts	21 0 11	paſture	hay	paſture	hay	paſture	hay	paſture	paſture	paſture
Crofts	21 0 0	⅓ peaſe ⅓ oats ⅓ clover	fallow	wheat	⅓ clover ⅓ peaſe ⅓ oats	fallow	wheat	⅓ oats ⅓ clover ⅓ peaſe	fallow	wheat
Overs	21 0 0	hay	paſture	rift oats	fallow	meſlin	oats	fallow	wheat	⅓ oats ⅓ peaſe ⅓ clover
Gravels	21 0 0	½ barley ½ turnip	½ turnip ½ barley	½ barley ½ turnip	½ turnip ½ barley	½ barley ½ turnip	½ turnip ½ barley	½ barley ½ turnip	fallow	barley and gr. ſeeds
Mains	21 0 0	hay	paſture	hay	paſture	hay	paſture	hay	pare ½ barley ½ turnip	½ turnip ½ oats.

A DRAUGHT of a LEASE.

This Indenture, *Made the day of in the year of the reign of our Sovereign Lord by the Grace of God, of Great-Britain, France, and Ireland, King, defender of the faith, and so forth, and in the year of our Lord one thousand seven hundred* BETWEEN A. B. *of the one part, and* B. C. *of the other part, WITNESSETH, that for and in consideration of the yearly rents herein after reserved, and of the covenants, clauses, and agreements herein contained, on the part of the said* B. C. *his executors and administrators, to be paid, done, and performed, the said* A. B. *HATH demised, setten, and to farm letten, and by these presents DOTH demise, set, and unto farm let unto the said* B. C. *his executors and administrators, ALL that messuage, farm, or farmhold, with the lands and grounds thereunto belonging, called or known by the name of* Thrivewell Farm; *and containing two hundred and eighty eight acres, one rod, and twenty-seven perches or thereabouts, situate, lying, and being at in the parish of and county of and now or late in the possession of as tenant thereof. TOGETHER with all and singular houses, out-houses, edifices, buildings, barns, byers, stables, garths, gardens, orchards, lands, grounds, hedges, hedge-rows, waters, water-courses, paths, passages, ways, easements, privileges, and appurtenances whatsoever to the said premisses, or any part thereof belonging, or in any wise appertainiug; EXCEPT, nevertheless, and always reserved out of this present demise, ALL woods, trees, mines, minerals, and quarries within and upon the said premisses; with liberty to cut down, plant, dig, sink for, win, work, take, carry away, and vend the same respectively; and to dig clay, make it into bricks or tyles, and burn the same in and upon the said premisses; with liberty to make and grant waggon and other ways and way leaves in, through, over and along the said premisses, for the purposes aforesaid, or any other purpose whatsoever, making such reasonable satisfaction to the said lessee or his heirs, for the damage to be done thereby to the corn and grass to be growing on the said premisses, as shall be set and ascertained by two indifferent persons, the one to be chosen by the said lessor, his heirs or assigns, and the other by the said lessee or his heirs; and in case the said two men so chosen can-*

cannot decide the matter, they are to caſt lots for the nomination of a third, whoſe determination ſhall in this matter be final. TO HAVE AND TO HOLD *the ſaid meſſuage, lands, tenements, and premiſſes, with the appurtenances, (except as before excepted) unto the ſaid* B. C. *and his executors and adminiſtrators, in manner following; (that is to ſay) ſuch parts of the tillage ground thereof as are to be fallow, or put under ſpring corn, from the ſecond day of February the meadow ground thereof from the fifth day of April and the houſes, paſture ground, and all other the ſaid premiſſes, from the twelfth day of May for and during, and unto the full end and term of nine years from thenceforth next reſpectively following.* YIELDING AND PAYING *for the ſaid premiſſes, yearly and every year during the ſaid term, unto the ſaid* A. B. *his heirs or aſſigns, the rent or ſum of of lawful money of Great-Britain, at two days of payment in every year; (that is to ſay) on the twenty-ſecond day of November, and the twelfth day of May, by equal portions; the firſt payment thereof to begin and to be made on the twenty-ſecond day of November next enſuing the date hereof.* AND ALSO YIELDING AND PAYING *unto the ſaid* A. B. *his heirs and aſſigns, the ſum of five pounds an acre, and as much more as the damage in any ſort can be valued in, for every acre of the ſaid demiſed premiſſes which he the ſaid* B. C. *or his executors and adminiſtrators ſhall let, aſſign, or ſet over to any perſon or perſons whomſoever, or which he or they ſhall plow up, or convert into or continue in tillage, or manage contrary to the ſcheme or courſe of huſbandry hereupon indorſed; the ſaid ſeveral and reſpective payments to be made on ſuch of the ſaid rent days as ſhall firſt happen next after ſuch letting, aſſigning, ſetting, converting into or continuing in tillage as aforeſaid ſhall reſpectively happen.* AND ALSO YIELDING AND PAYING *unto the ſaid* A. B. *his heirs and aſſigns, twelve-pence a rood for every rood of the hedges of the ſaid demiſed premiſſes which the ſaid* B. C. *or his executors and adminiſtrators, ſhall fail or neglect to ſcour, and otherwiſe dreſs as the ſaid* A. B. *or his agents ſhall direct, leſs than the yearly quantity herein after mentioned; the payment of the laſt mentioned ſum to be made on the twenty-fifth day of March in every year after ſuch failure or neglect. And if the ſaid yearly rent, or the ſeveral payments*

ments of five pounds, and of twelve pence, or any of them, or any part thereof, ſhall be behind and unpaid by the ſpace of twenty days next after the ſame ſhall reſpectively become due as aforeſaid, then, and from thenceforth, and ſo often as it ſhall ſo happen, it ſhall and may be lawful to and for the ſaid A. B. *his heirs and aſſigns, into the ſaid demiſed premiſſes, or any part thereof, to enter and diſtrain; and the diſtreſs and diſtreſſes there found, to take, lead, drive, and carry away, or the ſame there to detain and keep, or otherwiſe to ſell and diſpoſe thereof according to law, until the ſaid rent and payments, and all arrears thereof reſpectively, and all coſts and charges to be occaſioned by the non-payment thereof, ſhall be ſatisfied and diſcharged. And in caſe no ſufficient diſtreſs or diſtreſſes can be there found, had, and taken, whereby the ſaid rent and payments reſpectively can or may be fully raiſed and levied, that then, and from thenceforth, it ſhall and may be lawful to and for the ſaid* A. B. *his heirs or aſſigns, into and upon the ſaid demiſed premiſſes, and every part thereof, wholly to re-enter, and the ſame to have again, re-poſſeſs, and enjoy, as in his or their firſt and former ſtate, notwithſtanding any thing herein contained to the contrary thereof in any wiſe. AND the ſaid* B. C. *for himſelf, his executors and adminiſtrators, doth covenant, promiſe, and agree, to and with the ſaid* A. B. *his heirs and aſſigns, by theſe preſents, in manner following; (that is to ſay) That he the ſaid* B. C. *his executors and adminiſtrators ſhall and will well and truly pay, or cauſe to be paid unto the ſaid* A. B. *his heirs or aſſigns, the ſaid yearly rent, and the ſeveral payments herein before reſerved, at the ſeveral days herein before appointed for payment of the ſame reſpectively. AND ALSO ſhall and will well and truly pay and diſcharge all taxes and aſſeſſments whatſoever, as during the ſaid term ſhall become due and payable for the ſaid demiſed premiſſes for or in reſpect thereof, except land-tax. AND ſhall and will yearly, and every year, during the ſaid term, at ſeaſonable times in the year, well and ſufficiently ſcour, and otherwiſe dreſs, in ſuch places and in ſuch manner as the ſaid* A. B. *or his agents, &c. ſhall direct,*

roods *of the hedges of the ſaid demiſed premiſſes. AND ALSO mow, or otherwiſe deſtroy, yearly and every year, before their ſeeds are ripe, all the weeds that grow in every part of the ſaid premiſſes. AND ALSO ſhall and will preſerve all the reſt of the hedges of the ſaid demiſed premiſſes,*

and

and the windows, doors, locks, gates, gate-poſts, and ſtyles, barn floors, racks, mangers, cribs, and every other utenſil and inſtrument made for the uſe of the ſaid demiſed premiſſes, at the Expence of the ſaid A. B. *in good repair during the ſaid term, and at the end thereof ſhall leave them ſo repaired as aforeſaid. AND ſhall and will lay down to graſs the fields and cloſes called* the Standers and the Gravels, *part of the ſaid demiſed premiſſes, at ſuch times and in ſuch manner as in the ſaid ſcheme of huſbandry are mentioned in that behalf. AND ſhall and will, upon requeſt of the ſaid* A. B. *his heirs, aſſigns, or his or their agents, gather up all the ſtones which ſhall be found upon the ſeveral fields herein before mentioned to be laid to graſs; and ſhall carry and lay the ſame to and in ſuch places, within the premiſſes, as they or any of them ſhall direct. AND ALSO ſhall and will, upon ſuch requeſt, lead and lay at the place or places where the ſame ſhall be wanted, all ſuch timber, ſtones, bricks, tyles, lime, ſand and other materials as ſhall be uſed in and about the neceſſary buildings and repairs to be made and done in and upon the ſaid demiſed premiſſes, during the ſaid term. AND ſhall and will ſummer fallow the preſent tillage ground, and the ground herein after mentioned to be converted into tillage, in order or courſe, as are mentioned in the ſaid ſcheme or courſe of huſbandry. AND ſhall lay and in orderly manner ſpread upon every acre thereof fothers or wain loads of good clod lime, when and ſo often as the ſame ſhall be in fallow, and take no more than two crops from any part thereof, between one ſummer fallowing and another. AND that he or they ſhall and will eat and conſume with his and their cattle upon the ſaid demiſed premiſſes, all the hay, ſtraw and other produce thereof, (the ſtraw of the waygoing crop herein after mentioned only excepted). AND ſhall yearly lay and ſpread two-thirds of the manure thereby to be bred in & upon the land in tillage, and the other one-third on the meadow land in the winter ſeaſon, and regularly ſpread the ſame; except the manure which ſhall be bred in the laſt year of the ſaid term, which he or they ſhall leave for the uſe of the ſaid* A. B. *his heirs and aſſigns. AND that it ſhall and may be lawful to and for the ſaid* A. B. *his heirs and aſſigns, and his and their tenants, ſervants, and labourers, to enter into and upon the ſaid demiſed premiſſes at any time after the firſt day of January next before the end of the ſaid term, to ſcale and*

otherwiſe dreſs the meadows and paſture ground, and to pare or plow up any part thereof, paying or allowing a reaſonable ſatisfaction for the eatage of ſuch part only as ſhall be by him or them plowed up or pared. AND ALSO, that it ſhall and may be lawful to and for the ſaid A. B. *his heirs or aſſigns, (if he or if they think fit) to ſow with hay ſeeds, ſuch part of the ſaid waygoing crop, as ſhall be to be ſown with wheat or any other grain, or any part thereof, when the ſaid wheat or other grain ſhall be ſown thereupon, or in the ſpring next after ſuch ſowing. AND that he the ſaid* B. C. *his executors and adminiſtrators, ſhall not, nor will at any time during the ſaid term hereby demiſed, cut, or cauſe to be cut, or otherwiſe deſtroyed, any of the trees, wood, or quickſet hedges now ſtanding or growing upon any part of the ſaid demiſed premiſſes, or that may hereafter be planted or ſown, without the licence or conſent of the ſaid* A. B. *his heirs or aſſigns, or his or their agents, firſt had and obtained for that purpoſe; but ſhall and will, during the ſaid term, do whatever is neceſſary to preſerve the ſame. AND ſhall not, nor will keep, or ſuffer to be kept, any more or greater number of cattle or ſtints upon the ſaid premiſſes in the laſt year of the ſaid term, than were uſually kept thereon in the preceding years thereof. AND ſhall not, nor will permit or ſuffer, any new roads, paths, ditch, dyke, or fence to be made, in, through, or over the ſaid demiſed premiſſes, or any part thereof, nor commit, permit, or ſuffer any waſte or ſpoil to be made or done thereon during the ſaid term, except ſuch as the ſaid* A. B. *his heirs and aſſigns, &c. ſhall permit to be made. AND the ſaid* A. B. *for himſelf, his heirs, and aſſigns, DOTH covenant and agree, to and with the ſaid* B. C. *and his executors and adminiſtrators, by theſe preſents, that he the ſaid* B. C. *or his executors and adminiſtrators, (paying the rent and ſums of money herein before reſerved and mentioned to be paid, and performing the covenants and agreements herein contained on his and their parts to be done and performed) ſhall and may peaceably and quietly have, hold, and enjoy the ſaid demiſed premiſſes, during the ſaid term, without the let or hindrance of the ſaid* A. B. *his heirs or aſſigns. AND ALSO, that it ſhall and may be lawful to and for the ſaid* B. C. *his executors and adminiſtrators, to reap and take a waygoing crop of*

corn

corn off and from ſuch third part of the ſaid tillage ground, as are particularly and for that purpoſe mentioned in the ſaid ſcheme or courſe of huſbandry; with liberty to ſet and threſh the ſame in the ſtack-yard and barns belonging to the ſaid premiſſes, until the firſt day of May next, after the end of the ſaid term, provided he and they do threſh the ſame, and deliver the ſtraw thereof ſweet and clean to the ſaid A. B. *his heirs and aſſigns, or his or their ſucceeding tenant or tenants, at ſeaſonable times, for the food and ſupport of his or their cattle in the winter and ſpring next after the reaping thereof. AND ALSO, that it ſhall and may be lawful for the ſaid* B. C. *his executors and adminiſtrators, to pare, burn and convert into tillage the fields or cloſes, called* the Mains and the Overs, *part of the ſaid demiſed premiſſes, at ſuch times as the ſaid ſcheme or courſe of huſbandry mentioned for that purpoſe, and continue the ſame in tillage from the ſaid times reſpectively during the remainder of the ſaid term. AND that he the ſaid* A. B. *his heirs or aſſigns, ſhall and will keep all the main walls, roofs, and timber of the houſe or houſes hereby demiſed in good and tenantable repair, (this leſſee leading materials for ſuch buildings and repairs as aforeſaid). AND LASTLY, it is hereby declared and agreed, that the ſcheme or courſe of huſbandry herein before referred to, and hereupon indorſed, ſhall be taken and deemed to be a part of this preſent indenture of leaſe.*

IN WITNESS whereof, the ſaid parties to theſe preſents have hereunto interchangeably ſet their hands and ſeals, the day and year firſt before written.

Sealed and delivered, being firſt duly ſtamped, in the preſence of }

CONVERSATION XIX.

AGRICOLA.

SIR, I have not been able to prepare myſelf for the buſineſs you propoſed to enter upon, when we met again, in leſs than two days; notwithſtanding I was ſo thoroughly acquainted with the farm, that I had ſcarce any thing to enquire after: Hence, I think it will take any ſtranger a whole week to prepare for taking ſuch a farm, according to the ſyſtem before us.

Phil. A LITTLE practice would render the work eaſy, and greatly reduce the ſpace of time you deem neceſſary: But if it ſhould take every hour of it, a man better had ſpend a week in eſtimating accurately, and thereby fix himſelf and family comfortably for a term of years; as by ſcanning it over in a few hours, incumber himſelf and dependents for ſuch term, perhaps for life.

Agric. MOST certainly, Sir; but if the letter is a judge, and aſks the very price he intends to take, it ſaves a deal of trouble, and ends in the ſame amount.

Phil. BUT is there not a ſatisfaction in knowing, that a thing is juſt, from experiment: Beſides, if I was the letter,

I ſhould not think it right to propoſe a rent to ſome that would apply; but ſhould aſk them to name the rent they would give, after they had informed themſelves concerning the farm.

Agric. THEN you would take in propoſals, I preſume, Sir.

Phil. I CERTAINLY ſhould not countenance that execrable mode of letting farms, as you preſume, *Agricola*. Yet I ſhould think it very improper to riſk the mention of the rent of a farm, with perſons I had reaſon to believe were unprepared to judge of its value; becauſe their ignorance naturally would excite ſurpriſe; and as ſurpriſe, in ſuch people, is the parent of explanation, a farm cannot eſcape being cheapened, or having cold water (if I may uſe the phraſe) thrown on its letting. A circumſtance, letters of land have an equal right to avoid, as tenants have of being repreſented unequal to the payment of their rent, &c.

BESIDES, there is not a better way of knowing the abilities and diſpoſition of a tenant, than by his eſtimating and offering for a farm: For if he eſtimates with judgment, and bids conſiſtently, has capital equal to the undertaking, and bears a fair character, he ought to have the preference to every one, except the old tenant; and alſo of *him*, if *he* is not a perſon of equal abilities and worth. And moreover, I aſſure you, *Agricola*, ſuch a perſon ſhould not be held one minute in ſuſpence by me; for if he came to my eſtimation, it would certainly be equally as wicked as abſurd, to hold the farm longer up, in order to let it at a higher rent.

Agric.

Agric. IT is very well, Sir; but it is not unuſual to think a farm worth what it will fetch: Conſequently, it muſt be held up to the day of entering on it, to do it juſtice.

Phil. You begin to be pleaſant on the ſubject, *Agricola*; and I own, thoſe who have made ſuch a criterion the rule of their letting deſerves cenſure, notwithſtanding they ſeldom eſcape retaliation in another way: For when they let above value, they give latitude, for a ſhort time, and get tenants that have the heart to diſtreſs eſtates. But ſuch a career admits of few rotations; for theſe vultures in agricultute avoid, with infernal ſagacity, all connection, if they have not the breaking up (as they call it) of the eſtate.

Agric. NOR are the proprietors leſs blameable than the tenants, in my opinion, Sir, when eſtates are exhauſted by improper huſbandry; becauſe they receive a conſideration for permitting them to be ſo treated.

Phil. I AM of your opinion, *Agricola*; and have told you ſo, if I miſtake not. In ſhort, I am ſo thoroughly perſuaded that it ought to be provided againſt by the legiſlature; eſpecially where the eſtates are in entail; becauſe, in fact, it is ſelling the marrow, and leaving their ſucceſſors nothing but the dry bones. But let us attend to the buſineſs propoſed; in order to which, I hope you have made out, in writing, a fair eſtimate.

Agric.

Agric. I HAVE, Sir, to the utmoſt of my power, endeavoured it; and am nothing leſs than in earneſt to take the farm.—Here is the eſtimate, pleaſe to peruſe it.

Phil. I DO not ſay, that every perſon who goes to treat for a farm, ought to ſhew the landlord or ſteward his eſtimate; nor that the landlord, or his ſteward, is to ſhew theirs to thoſe that come: But I inſiſt, that it is right that they ſhould each have one; and as you are ſo candid, as to produce yours to me, I much thank you, and ſhall peruſe it.

An ESTIMATE *of the* RECEIVINGS *and* EXPENDITURE, On the FARM, called THRIVEWELL, for one Year,

Taken as a prime Average for the propoſed Leaſe.

Expenditure. *Dr*	£.	s.	d.	Receivings. *Cr.*	£.	s.	d.
To the expence of 48 buſhels of fine ſeed wheat & pickle	15	0	0	By the produce of 21 acres of wheat, at 22 buſhels per acre, and 5s. per buſhel -	115	10	0
To 33 buſhels of ſeed barley	5	0	0	By the produce of 11 acres of barley, at 50 buſhels per acre, and 2s. 6d. per buſh.	68	15	0
To 15 buſhels of peaſe -	2	10	0	By the produce of 5 acres of peaſe, at 30 buſh. per acre, and 3s. per buſhel —	22	10	0
To 44 buſhels of oats —	3	10	0	By the produce of 11 acres of oats, at 48 buſhels per acre, and 1s. 6d. per buſh.	39	12	0
To 100 lb. of red clover ſeed	2	0	0	By 10 acres of turnips, at 3l. per acre — —	30	0	0
To 10 lb. of turnip ſeed -	0	10	0	By keeping ſix cows —	60	0	0
To the expen. of corn harveſt	20	0	0	By ſummer feeding twelve yield cows — —	30	0	0
To the expen. of hay harveſt	10	10	0	By ſummer and wintering ſix ſteers — —	18	0	0
To the exp. of hoeing turnips and other matters relating them —	5	0	0	By the improvement of four work oxen — —	6	0	0
To the expen. of a ſhepherd	18	0	0	By keeping ſix two-year old beaſts, and ſix three-year old ditto — —	24	0	0
To the exp. of ſalve, ſheering, and loſs by various means, unprovided for -	15	0	0	By the produce of 260 ſheep, kept on the Downs, picking the ſtubbles, &c. -	130	0	0
To the exp. of two men, & two boys, kept to plow, harrow, ſcour hedges, and threſh the crop, &c. &c.	56	0	0	By keeping two ſows, on clover & refuſe corn, &c.	24	0	0
To the exp. of a woman ſervant, to manage the dairy	12	0	0	By what may be cleared by poultry of different ſorts	5	0	0
To the exp. of corn for ſeven horſes employed in working the farm —	21	0	0	By what may be made by foals out of the team horſes	10	0	0
To the exp. of lime & dung for the farm, over what it produces — —	10	0	0	By what may be cleared by keeping bees — —	5	0	0
To the expen. of weeding	1	10	0	By what may be cleared by gathering acorns, beech, maſt, coans, and higle, from the trees and hedges* -	5	0	0
To the exp. of ſcaling and catching moles — —	1	15	0	By what may be cleared by a dove cot — —	5	0	0
To the exp. of ſmith-work and iron — —	8	0	0	By what may be cleared by making up two young horſes for market — —	10	0	0
To the exp. of wood and carpenter work, ſadler's bill, &c. — —	3	19	0	Whole receivings — —	608	7	0
To the exp. of bull, &c. -	3	3	0	Whole expence —	350	7	0
To ceſſes and poor-rate -	26	0	0				
To the expence of turnpike, and marketing the produce of the farm	10	0	0				
To the farmer for ſowing the crop, and his daily attendance — —	40	0	0				
To the intereſt of 600l. at 10 *per Cent.* — —	60	0	0				
	350	7	0	Rent — —	258	0	0

* It is not intended,——*ſee the next page.*

THE eſtimate is very plain, *Agricola*; and in the moſt natural manner ſhews, that the rent, or conſideration money to be paid for a *Farm*, when *it* is well managed, and every iota for and againſt *it* brought to account, ought to be neither more nor leſs than what the income exceeds the out-goings.

I AM alſo of opinion, *Agricola*, that you have ſuited the land and ſituation very properly with ſtock: But have you not ſubjoined very ſmall prices for grain, and kept ſomewhat within with reſpect to the gift or increaſe from ſowings?

Agric. To the beſt of my knowledge, I have not, Sir: For as you informed me, that you made the eſtimate the criterion to judge of the tenant's abilities, I have been as cautious as poſſible, to avoid forfeiting your eſteem. It may, however, ſeem to you that the prices are too ſmall, becauſe I own they are not the average prices for a ſeries of years paſt: But as importation of corn is ſo much encouraged, and exportation as much diſcouraged; and moreover, as money begins to be dearer, and corn actually cheaper, I thought it a warrantable ſpeculation to affix the above ſums reſpectively; and can ſee

* IT is not intended, by taking notice of the above, that proprietors of land are to attend to ſuch *minutiæ* as the higgle or haws that grow on the hedges, when they lay on the rent: But that where there are valuable plantations of pines, beeches, &c. and ſtore of fine oaks, that their fruit ſhould be brought to account, either by landlord or tenant, as the trees thrive better by being culled, if properly done, at the proper ſeaſon: And particularly, as it bids fair to reduce the price of ſuch plants, and thereby facilitate a great national concern, the growth of uſeful timber.

no reaſon why I ſhould alter them. And with reſpect to the increaſe on the ſowings, it is evident to me, that for as much as ſome of the fields will yield a good deal more, that others may fall as much ſhort; and alſo, that altho' in good years of corn, the produce will be better, both in quantity and quality, than eſtimated; yet in other years, the produce may be as much inferior, in both reſpects: So that, upon the whole, I am perfectly at eaſe in my mind, with regard to any intentional wrong in the eſtimate; and, if it were not for being under ſo kind a landlord, and amongſt ſuch reſpectable neighbours, to have, or not have the farm, at the above ſum, would be quite indifferent to me.

Phil. AND this I am to take as the laſt ſpeech and dying words of Mr *Agricola Foreſight*, whom I muſt beg leave to reſt aſſured, that if it were not for the ſake of having ſuch an obliging and deſerving tenant, I would not abate of the eſtimate I have made of the rent of *Thrivewell*. However, on the above account, if he is alſo agreeable, ſhall half the difference; which at the ſame time it gives preference to the judgment of neither of us, will make the rent the even ſum of 260l. a year.—And this is all I have to ſay on the ſubject.*

Agric. HAPPY to find our eſtimates were ſo nearly alike; and for ſo trifling a ſum as forty ſhillings a year, I cannot let ſlip the opportunity; ſo agree to your offer, Sir.

Phil.

* IMITATING *Agricola*'s manner and cant.

Phil. YOU are very welcome, *Agricola*; and for the preſent, we ſign a memorandum of the agreement; for a leaſe cannot be executed until you enter upon the premiſſes.

Proper FORM of an Agreement for a Farm,

To be indorſed on the DRAFT of the LEASE.

Memorandum, Made this 26th day of *November*, 1775, between *P.* of on the one part, and *A.* of on the other part; as follows, *viz.*

THE ſaid *P.* in conſideration of the rent and conditions mentioned in the annexed draft of a leaſe,* DOTH agree to demiſe and let, on a leaſe ſimilar to the ſaid annexed draft, all that Farm therein mentioned, with all its appurtenances and emoluments, as therein ſet forth.

AND the ſaid *A.* in conſideration thereof, DOTH agree to take the aforeſaid farm or premiſſes, for the term of nine years, at the rent of two hundred and ſixty pounds a year, as ſet forth in the ſaid annexed draft of a leaſe. AND ALSO to execute a counter-part of the aforeſaid leaſe, when it is preſented to him in a lawful manner and form.

Witneſs, *P.*
C. C. *A.*

Agric.

* FILL up the blanks left for the rent, quantity, and ſcouring of the hedges, time of entry, &c. &c.

Agric. Now we are agreed, Sir; I wiſh to have your opinion on the manner I intend to treat that field, called *Summers*; which, you know, is as deep as the plough uſually goes a looſe mooriſh ſoil, and always, after fallow, burſts under the crop in ſpring; conſequently renders it but of little value.

Phil. WITH the utmoſt chearfulneſs I ſhall give you my opinion, and aſſiſtance too, if neceſſary, *Agricola*; ſo propoſe your method.

Agric. I HAVE obſerved, that immediately under the looſe ſoil which the plough works in, there is a *clay*: And it is from it I hope to be furniſhed with a remedy againſt this deſtructive burſting or leaping; as the next time it comes to fallow, in the beginning of winter, I purpoſe to plow *it* up two inches deep, and keep *it* on the ſurface all the winter, to meliorate by the froſt. In the courſe of the ſummer, ſhall give the fallow a dreſſing of lime and dung; and alſo all the plowings, harrowings, &c. that ſeem neceſſary, to give it the beſt chance for a crop; and from both theory and experience, I have the greateſt hopes of ſucceeding to my wiſhes.

Phil. I CONGRATULATE you on the thought, *Agricola*; and where the clay lies too deep for the plough to raiſe, I will aſſiſt you to dig and carry it upon it.

IT undoubtedly is, on ſuch ſoils, that claying is an immediate and laſting improvement: Conſequently, not only the tenant's advantage, but alſo the landlord's. Marl has alſo a ſalutary effect in ſuch caſes; but this ſort of remedy is not always at hand; neither is clay indeed; and when none of them

them can be had, winter fallowing, and ſevere rolling in the the ſummer, after the land is cleaned, and when it is between wet and dry, is a good ſuccedaneum for either.* It will alſo be found an improvement where the ſtaple is thin, and the ſtratum immediately under it is clay, or inclinable thereto, to take up a ſmall quantity of ſuch matter, every other fallow, and lay it upon the *ſtaple*, as the whole will be rendered thereby conſiderably more compact, and conſequently a fitter covering for the roots of the plants in froſts. It will alſo better retain the manure for the uſe of the crop, encourage fermentation, attract the virtues of the atmoſphere, &c. But care muſt be taken to avoid over-doing it with this allay, leſt the bad effects I have formerly mentioned, relative to this matter, ſhould obtain.

ALLOW me alſo to propoſe to you, *Agricola*, a ſmall alteration in the manner of feeding down the ſkirts of the downs, that

* A ROLLER for ſuch work is deſcribed in the *Muſeum Ruſticum*, vol. IV. page 5, &c. But as I have made ſome improvement of it, and as the account there given of it is very incorrect, pleaſe attend to what follows concerning it. Take two blocks of ſtone, each, when dreſſed, four feet diameter, and fifteen inches thick: Put an eye in the center of each, as if for a millſtone; and firſt buſh them with wood, and then with metal, and hang them on an axle-tree, and cauſe them to be tread (outſide and outſide) five feet apart. Hence, if the horſes are well managed, the intermediate ſpace will be covered without waſte of labour. A carriage and ſhafts are to be connected to the axle-tree, and ſuch a number of horſes applied as will work it properly. Repeat the rolling until the field is like a common road; which, by the bye, is not ſo arduous a work as may at firſt ſight appear to be, nor has any mode of culture a better effect. A cart with nine-inch wheels, properly loaded, is not a bad ſubſtitute for this ſort of roller. The uſe of the ſpiky roller, on ſtiff ſoils, is already ſo well known and attended to, that there is no occaſion to recommend it.

that are liable to be flooded: They have always hitherto been fed down with ſheep, and I believe you propoſe to do the ſame. However, as it amounts to more than mere conjecture, that the principal loſs that has attended the ſheep ſtock on that farm, has been occaſioned by their eating the graſs that fluſh up immediately after a flood, on thoſe ſkirts: I ſhall bear the expence of fencing from your flocks, provided you will allow me; and will ſtock them with hardier ſtock.

Agric. I AM much obliged to you, Sir; and ſhall ſtock them with hardier ſtock, moſt certainly; for I doubt not that the rot in ſheep may be occaſioned by feeding on graſs ſaturated with an inflammable principle, as well as continual breathing in ſuch air.

Phil. THERE is no doubt of it, *Agricola*; and as I did not ſo earneſtly caution you againſt the baneful effects of ſuch food, as againſt the bad effects of ſuch air, I have taken this opportunity to reſume the ſubject; and would have you extend the principle even to neat cattle; for there is but too much reaſon to preſume, that the dreadful murrains, which have made ſuch havock among that ſpecies of animals, have been occaſioned by cattle feeding down groſs herbage, drinking bad water, and breathing in contaminated air.

HENCE, all new laids, eſpecially thoſe that have been dreſſed with dung, meadows that have been lately top-dreſſed, and graſs encouraged by rich water, ought to be freed until ſuch herbage is hardened by time, or purified by froſt:

For

For altho' vegetables have the virtue to reclaim contaminated water, air, &c. yet if they are taken when young, and conſequently full of the groſs inflammable principle, there is reaſon to ſuſpect, ſuch will not be friendly to the animal œconomy.

End of the Firſt Section.

SEC-

SECTION II.

ELEMENTS

OF

PRACTICAL

MECHANICS:

WITH

The APPLICATION thereof

TO

RURAL AFFAIRS.

ELEMENTS

OF

ALGEBRA

The ARGUMENT.

WE need but take a comparative view of man's ſmall degree of ſtrength, and his great atchievements, to be thoroughly convinced, that ſuch atchievements are the conſequences of his adorable Creator permitting him the free uſe of MECHANICS; as by them the utmoſt improvement is made of every power and force in nature; and every element made ſubſervient to the various purpoſes of life!

SUCH diſtinguiſhed and excluſive *privileges* ought to fill our hearts with gratitude to the donor; and our own *intereſt* ought alſo to incline us to contemplate the principles and application thereof with aſſiduity and care.

HENCE, an attempt to illuſtrate a ſubject of ſuch importance, can need no apology.

MECHANICS.

THE Method propoſed for drawing up this Compendium of Mechanics, is—*Firſt*, To point out the obſtacles that Mechanics have to combat——*Second*, The *Powers* and *Inſtruments* that are to ſubdue thoſe obſtacles——*Third*, The proper manner of employing thoſe Powers and Inſtruments.

THE firſt and moſt ſovereign obſtacle is, The *attraction of gravitation*, or that power by which all kinds of bodies near, and upon, the earth, tend to her center.

THE ſecond is, The *attraction of coheſion*, or that power by which all ſolid bodies are held together.

THE third is, The *elaſticity of bodies*, or that power which moſt ſubſtances have to reſume their priſtine form in ſome degree.

THE fourth is, The *preſſure and impulſe of fluids*, ſuch as water, wind, &c.

THE fifth is, The *aſperity or roughneſs* of ſurfaces.

THE

THE ſixth is, The *vis inertiæ*, or inert principle in matter, that makes it indifferent both to motion and reſt.

THE natural powers that man is capable of exerting, to overcome, or even balance any of theſe obſtacles, are derived either from the exchange of force for force, in a direct proportion; or part force, and the reſidue time, in lieu of force. But this ſhould not abate our gratitude and thankfulneſs to the Author of Nature, for the free uſe of mechanics: Becauſe, every creature is better for exerciſe; and it muſt be of the laſt importance to man, to have it in his power to exchange time for every convenience of life.

LET us take a view of this ineſtimable bleſſing, as it exiſts in our own affairs: Have we a large block of ſtone or wood to raiſe a conſiderable height, and not be ſenſible that a ſet of pulleys, or a windlaſs, with two men's work, will be of greater avail than twenty men with their bare hands. The mariner is alſo well aware of this; for if it were not for ſuch combination of natural powers, he muſt carry fifty men to weigh anchors and hoiſt ſails, when five are ſufficient to do the buſineſs with the help of mechanics, that handy medium, through which he and all mankind can barter time for force, with much convenience. But we prove this by the *lever*, the moſt ſimple, and only original, mechanic power.

FIRST, then, let us ſuppoſe the lever A B, plate V. fig. 1, No. 1, loaded at point A, with 100 lb. and made to turn upon a pin or fulcrum at E: It is ſelf-evident, that at a ſpace equidiſtant from

from the fulcrum on the other end of the lever, *a c*, it will require 100 lb. to counter-balance the point A. It is alſo ſelf-evident, that to bring theſe equidiſtant points A C, and *a c*, upon the horizon, or to ſtand in equilibrio, the point A muſt move from its preſent ſituation up to C; and point *a* muſt alſo move from its preſent ſituation down to *c*; which ſpaces are exactly equal, and they will perform them in equal times. It is alſo obſervable, that the point B will alſo deſcend to point D, in the ſame time, altho' the ſpace is exactly ten times as great. Hence, it is clear, there is a gain of velocity or ſpace, in the proportion of ten to one. But the conſequence of this is, that if 100 lb. be laid on point B, when it is in point D, it will require 1000 lb. to be laid on point A, to move it from point D to its preſent ſituation; and point A can only move from point C to its preſent ſituation in that time:* From which it is evident, that the velocity or ſpace gained by point B, occaſioned a loſs of power in the ſame proportion in the ſaid point, when point *a* A was made the acting lever. Hence we have the axiom, what we gain in ſpace, we loſe in power, and *vice verſa*.

Now, as point A, by ſaving the expence of paſſing through nine-tenths of the ſpace B D, loſt an equal proportion of power; it follows, that as point B was at the expence of paſſing through nine-tenths more ſpace than point A, that point B gained thereby nine-tenths of the whole power. So 10 lb. on B would be an exact counterpoiſe for 100 lb. on A; and the diſtance from B to E, will be ten times the diſtance A E.

* May be proved by the Steelyard.

A E.——What obtains on the extremities of theſe levers, muſt alſo obtain on their intermediate diviſions in like manner, viz. circle 2, 2, will have twice the power that circle 1, 1, has; and circle 3, 3, three times the power of circle 1, 1; and ſo on.

THE very ſame reſult obtains in uſing an inclined plane, as may be proved by experiment, thus: Let any ſpherical body, as D, fig. 2, be drawn up the inclined plane A B, by a cord properly connected to the center of ſuch ſpherical body, and brought over a pulley at B, the cord being exactly parellel to the inclined plane; and any body, one-tenth of the weight of the ſpherical body, put to the end of the cord, and allowed to deſcend in direction B C, with a ſmall addition of weight to overcome the friction of the parts in action, will draw the ſpherical body up the plane from A to B. But as diſtance B C, is only equal to diſtance 9, 10, and alſo only equal to every one of the other diviſions on the inclined plane, of which there are ten from A to B; it is evident that the deſcending weight muſt go through ten times the ſpace B C, to raiſe the ſpherical body D through the ſpace B C, in a perpendicular direction.

THE wedge, fig. 3, derives its power from the ſame principle. Hence, the momentum or force that drives it, muſt be made ſuitable to the thickneſs of the wedge at W, *cæteris paribus*.

THAT the ſet of pulleys, fig. 4, and every other ſet of pulleys, are ſubject to the ſame law, or are in fact levers, appear plainly from the following inſtance, viz. That as arrow A, muſt paſs through four times the ſpace that arrow B muſt paſs through, to

to arrive at point C, in the ſame ſpace of time that arrow A arrives at point C: Therefore a weight ſuſpended at B, may be raiſed by one-fourth of its weight ſuſpended at A. This being fully aſcertained by experiment, it follows, that the power of any combination of pulleys whatever, may be eſtimated by comparing the ſpace that the body raiſed has or will paſs through in a given time, with the length of the fall of tackle or rope that has paſſed through the men's hands that hauled it, &c. in the ſame ſpace of time. For inſtance, if the weight raiſed be 12 tons, and the power applied to raiſe it 40 ft. or the 48th part of 12 tons; the fall of the tackle that has paſſed through the men's hands will be juſt forty-eight times as long as the height the weight was raiſed. In like manner, the quantity of power applied may be eſtimated: For the quantity or exceſs of ſpace, gives exactly the proportion of the power and reſiſtance to each other.

ALL manner of SCREWS are ſubject to the ſame law; for the weight A, fig. 5, plate V. cannot be raiſed with a force any thing leſs than itſelf, unleſs ſuch force move through a larger ſpace in a given time. Hence, if weight A (being one ton) is raiſed one foot in a minute of time by the force of 10 ft. or $\frac{1}{10}$ of weight A, the arbor of the ſcrew muſt paſs through ſixteen times the ſpace in that time. And as the points B B, where the power of force is applied, are farther from the center than the arbor, the ſpace will be thereby increaſed in a direct proportion

tion to their reſpective diſtances from the center of the ſcrew or pin, No. 1, *ib.* as may be fully proved by experiment, if care is taken to make fair allowance for friction.

THE ſcrew may, therefore, be taken either as a lever, or inclined plane thruſt under a weight; ſince its force is to the ſpace gone through, exactly as the hypothenuſe *a b*, is to the perpendicular *b c*, vide No. 2, fig. 5, *ib.* and fig. 2; or as the active or longer arm of a lever, is to the ſpace beyond the fulcrum or pin it turns upon.

THE wheel and axis, or axis in *peritrochio*, (as it is often called) is alſo a combination of levers; and the gain of force upon it is always in proportion to the ſpace gone through by the firſt mover. For inſtance; if the weight A, fig. 6, plate V. aſcends 12 feet in one minute, by a perſon turning the winch G, $1\frac{1}{2}$ foot radius, which turns the lanthorn or pinnion H, with twelve rounds or teeth, which lanthorn turns the wheel X, with 96 teeth, to which wheel is fixed the axis or roller E, one foot radius, round which the rope that pulls up the weight is coiled, the hand that turns the winch muſt move through a ſpace of 144 feet in one minute. Hence, a perſon plying the winch with ſuch velocity, and with the force of 12 lb. would raiſe 144 lb. at A, twelve feet in one minute, with ſuch a machine, except what would be abated by friction.

DEMONSTRATION.

THE axis or roller E, being two feet diameter, it muſt be ſix feet in circumference (in ſtrictneſs it will be ſome inches more, for the diameter of a cylinder is to its circumference as 7 is to 22 nearly; but to avoid giving perplexity to the reader, I wave the fractional parts.) The axis being ſix feet about, muſt revolve or turn twice round, to take up the rope the weight is ſuſpended by twelve feet. And as the wheel X is fixed to its axis or roller, that wheel muſt alſo revolve and turn twice round along with it: And as the wheel has 96 teeth, and the lanthorn or pinion that works in it has only 12 teeth, the lanthorn muſt turn eight times round for the wheel's once; becauſe, the number of teeth the pinion contains is eight times got in the number of teeth the wheel contains. And moreover, as the wheel makes two revolutions, the pinion, and conſequently the winch (for it is fixed in it) muſt make ſixteen revolutions to raiſe the weight 12 feet.

Now, as the winch makes ſixteen revolutions, and is 1 foot and a half radius, by the ſame rule we computed the circumference of the axis or roller which the weight was fixed to;* each revolution of the hand that worked the winch, muſt go through 9 feet. The whole ſpace, therefore, which the hand will paſs through in the above operation, is 16 times 9, or 144 feet, as before aſſerted.

* Viz. That thrice the diameter is equal to the circumference.

If any perſon thinks proper to uſe this ſort of machine, or combination of levers, which is very proper for raiſing heavy weights with little force, it will be an improvement to have it made with a fly or wheel *o o*, and pins in the periphery or outer rim of it, as *a a*.

First, becauſe ſuch fly regulates the perſon's force applied to the winch, which, without ſuch regulation, will be exceedingly irregular: For when the perſon's arms are upright, the utmoſt force that he can exert, is not one-tenth of the force he can apply, when his arms are in the loweſt ſituation: As, in the latter poſition, the extenſers of the back and thighs act in concert with the muſcular force of the arm; whereas, in the former poſition, it is impoſſible for the perſon that turns the winch to act with any greater force on it than what the bare leaning of his body towards it occaſions.

If there is occaſion to employ two men in working this machine, it will much aſſiſt the fly in regulating the force, if the handles or winches are put on at right angles, or 180 degrees diſtant; becauſe then the one man is ſtrongeſt, or nearly ſo, when the other is weakeſt. I know this matter is controverted; and that very reſpectable *authors* have aſſerted, they ought to be put at 90 degrees; yet, as I have not found it contradicted in practice, nor can theory contradict it, I beg leave to contradict *them*; and to aſſure thoſe who uſe ſuch inſtruments, that there is no better mode of fixing handles or

winches than at right angles, provided the men that work them take a proper ſtand; and that is to be regulated by the ſize of the men, and by no other rule.

It is alſo neceſſary, in order to enably the *fly* to regulate the applied force and motion of the machine, to have *it* of ſuch ſize and weight, and the motion or degree of velocity ſuch as may occaſion a proper degree of centrifugal force to obtain; otherwiſe, *it* will be of little or no avail to the machine: For the centrifugal force muſt conquer the force of gravity before any advantage can be acquired by a fly; and that cannot be the caſe until the periphery of the fly move at leaſt 8 feet in one ſecond of time. Conſequently, as a man cannot (to uphold it for any conſiderable time) make above thirty revolutions in one minute; if the fly is fixed on the ſame axis he immediately acts upon, the fly muſt be five feet and a half diameter at leaſt, to regulate his force and the motion of the machine in a proper manner.

Secondly, If pins are fixed in the outer rim of the fly (as before intimated) and every member of the machine is ſufficiently ſtrong and well proportioned, a man of ordinary ſtrength and weight, may, by thruſting his feet into ſtraps faſtened to the floor or ſcaffold he ſtands upon, and pulling theſe pins regularly, raiſe with a machine of the calculation above, five ton, twelve feet high, in a quarter of an hour.

The

THE reaſon for faſtening the perſon's feet who pulls the pins to the floor, I think, muſt need little illuſtration; particularly if it is conſidered, that we can pull no more than our own weight right downward, unleſs we are held to the baſis we ſtand upon; as any perſon may ſoon be convinced of, by putting his own weight at one end of a rope that is ſuſpended on a wheel, and exert his greateſt effort at the other end of the rope, when he will find it impoſſible to raiſe ſuch counterpoiſe from its baſis, unleſs for a moment, and then it will return on him: But when his feet are confined down, he can then add his whole muſcular force to the weight of his body, and thereby raiſe a weight greatly ſuperior to that of his body.

THERE are ſeveral other kinds of *levers* made uſe of, beſides what have already been treated of, viz. ſuch as No. 2, in fig. 1, *ib.* where the fulcrum or reſt of the *lever* is at *its* point A, and the weight or body to be raiſed either upon the back of the *lever*, as B, or hooked to *it*, as weight C. The gain of power on ſuch lever will be as in the preceding caſes, exactly as the diſtance of the hand D, or power that lifts the lever up from the place of ſuſpenſion of the weight C, or center of gravity of the load B, is to the diſtance from the fulcrum or point of ſupport A, to the place of ſuſpenſion, &c. which in this caſe will be four to one, as appears by the figure. This ſort of lever is called a lever of the ſecond kind; No. 1, *ib.* is called a lever of the firſt kind; and No. 3, *ib.* is called a lever

lever of the third kind, and is only uſed for convenience, as in raiſing a ladder or ſtay, &c. &c. or to gain velocity, for it is the reverſe of all the other levers, as it requires power in exchange for ſpace, as the figure indicates: For, let the point or fulcrum be A, and the power be applied at B, and body to be raiſed be C; it is evident that the ſpace C will paſs through, will be greater than the ſpace the power paſſes through: Hence, from the properties of this lever, weight C will have greater force than power B, in proportion to their diſtances from the wall or fulcrum at A reſpectively; which in this caſe will be as 3 to 2; all which is ſo clear from a bare view of the figure, that it is unneceſſary to inſiſt any further on that particular.

THE balance is by many reckoned a mechanical power; which appellation, I own, I can by no means allow it: Yet, as it is a mechanical inſtrument, and is ſo eſſential to buſineſs as to become the criterion to diſtinguiſh the value of almoſt every article in trade, I think it merits our notice in a particular degree; ſhall therefore conſider its properties with ſingular attention.

THE primary excellence of a good balance, is to be altogether free from the principle of a lever.* The arms *a b*, and *P a*, as in fig. 7, plate 5, ſhould always be exactly of one length; for if they

* This circumſtance deſtroys the idea of its being a mechanical power; as there is no power in mechanics, but what is derived from the lever.

they are the ſmalleſt matter otherwiſe, it muſt and will conſtitute a falſe balance. The arms of a balance ought alſo to be exactly ſimilar with reſpect to ſhape, quality, and figure; for, altho' ring *q*, by reaſon of the arm it is affixed to being heavier than the oppoſite arm, is an exact counterpoiſe for ring P, on the oppoſite arm, when the beam is in a horizontal poſition; notwithſtanding ring P is placed at a greater diſtance from the the center of motion, yet when the beam is in an inclined poſition, the effect of gravity will be unequal; becauſe the center of gravity of the beam will change in that caſe with the change of poſition. It is neceſſary alſo, on the ſame account, to have a counter index D, to enable the beam to recover a horizontal poſition when it is made to ſwing upon its center; a circumſtance that every perſon who ſells goods by weight, ought to attend to, in order to avoid being ſuſpected of keeping a falſe beam, as well as doing themſelves and their cuſtomers juſtice.

And the beam that will beſt anſwer thoſe purpoſes, is to be made with its center of gravity below its center of motion, that is, the pin or nail as it is ſometimes called, which conſtitute the center of motion, ought to be a little higher than the middle of the beam,* made as thin, as well poliſhed, and as much hardened as poſſible: And the eyes of the ſheers on which it

* In the beam, fig. 7, there are three dots, one in the middle of the beam, one above it, and one below it. It is that above which ſhews the place for the lower edge of the nail.

it has its bearance, large, nearly flat at bottom, hard, and of a nice poliſh. It is true the beam may be very juſt when its center of motion and center of gravity are in the ſame point; but it will too ſoon, in that make, come to reſt to give every buyer content. I do not mean by this obſervation to inſinuate, that buyers are blameable in requiring the beam to vibrate; for there is a beam that will, in the hand of a deſigning *ſeller*, groſsly impoſe on the *buyer*, notwithſtanding *his* utmoſt watchfulneſs: and yet it is a juſt beam, and will decide the comparative weight of bodies to the greateſt nicety, if fairly waited on. This beam is the ſame as any of the above, except in the ſituation of the center of motion, which in it is placed below the center of gravity: Whence, if a caſt be once given, even to the lighteſt ſcale, it cannot eaſily be regained; and on this deception an unprincipled ſeller may avail himſelf. Hence it is neceſſary to have a beam to vibrate, as then the buyer is certain of its fairneſs.

BESIDES theſe particulars, in order to give a beam the beſt chance to determine the comparative weight of bodies, it is proper to ſuſpend the ſheers by a flexible body; for if they are faſtened in or to an inflexible body, and do not make a perpendicular with the horizon of the place, the index of the beam will not be parallel to the ſheers when the arms of the beam are in equilibrio. It is alſo neceſſary to have the ſcales ſuſpended by flexible bodies, and the pins or eyes in the ends of the beam,* or through which the hooks or eyes that connect the cords of the ſcales to ſuch hooks or eyes, made hard, thin,

* Pins in the beam are beſt.

thin, and well poliſhed, and the whole to hang exactly perpendicular; for if the one ſcale is tucked outward, and the other hangs perpendicular, that tucked outward will gain a lever purchaſe, and thereby deſtroy the truth of the beam.

THE ſtrength of the beam ſhould alſo be attended to; for if a ſlender beam be taken to weigh a heavy body, its arms may be bent out of the true poſition, and thereby render it incapable of ſhewing the preciſe weight of that or any other body. And if a large beam is taken to weigh a ſmall body upon, the body, if it is very ſmall, may not be able to change the center of gravity of ſo large a beam, and then the commodity intended to be weighed will tell to no weight at all. It is therefore in this matter, as in all other caſes in buſineſs, a fitneſs of the utenſils are neceſſary to a perfect concluſion thereof.

The length of ſcale beams is alſo a circumſtance that requires the attention of thoſe who either buy or ſell by them; but as experience itſelf is ſufficient to prevent any material error in that reſpect; I think any further eſſay on that circumſtance unneceſſary.

THE length of the cords which ſuſpend the ſcales is alſo a circumſtance that experience and convenience are ſufficient to adjuſt; for whether they be long or ſhort, or whether they be equally long on each ſcale, makes no odds of the comparative weight of the bodies that are on the ſcales, provided the

ſcales hang perpendicular to the beam when it reſts in a horizontal poſition, and the inequality of length of the cords does not exceed 6 feet. But the ſize of the ſcales is a matter that ſhould be attended to moſt ſcrupulouſly; and likewiſe the bulk of the weights that are put in the ſcale to determine the weght of commodities, eſpecially bulky commodities, ſuch as ſilk, cotton, wool, &c. &c. becauſe, when the atmoſphere is heavy,* a greater quantity of any of thoſe commodities is required to counter-balance a weight of lead, &c. than will do it when the atmoſphere is light. However extraordinary this remark may appear to readers that are not converſant in the ſcience of pneumatics, they may depend upon its authenticity;† and that when the atmoſphere is taken at its extreme height, viz. at 31 inches in the barometer, the difference will be amazing, and far exceed a fair profit to the buyer: And when the atmoſphere in the other extreme, viz. at 28 inches, the advantage will fall to the ſeller in the ſame proportion. The beſt way to prevent ſuch an inconveniencc is to have the ſcales made exactly of an equal figure and capacity, and ſo large and hollow as to contain the whole quantity taken at one weigh, within the ſcale. This may be done either in ſtrong tin or thin copper worked into hemiſpheres, and a ring of

* The barometer or weather glaſs is the proper inſtrument to point this out. Its table being graduated for that purpoſe: and when the mercury is higheſt, the atmoſphere is heavieſt, and *vice verſa*.

† It is eaſy to prove it by weighing the ſame things in different ſtates of the atmoſphere.

of ſtrong braſs or iron wire drawn round their mouths, to prevent the cords and load deſtroying their circular form. Thus the reſiſtance of the *atmoſphere* will be made equal againſt the weight and commodity that is put againſt *it*, altho' their bulks be ever ſo unequal, and *the* medum in which they are weighed denſe or rare.

FROM this view of the matter, it is evident that the *ſtatera-romana*, or ſteel-yard, in its common form, muſt be very fallacious, as the weight and commodity to be weighed in general are exceedingly diſproportionate in bulk. This, togethe rwih the many other difficulties which attend that inſtrument, with regard to determining the comparative weight of bodies, viz. its requiring to be laid exactly in the horizon of the place where uſed; the almoſt impoſſibility of graduating it to truth, and keeping two of the three points of ſuſpenſion in a line at all times, matters that ought to be ſcrupulouſly attended to, more than balance the convenience of its portable form, &c.

IF the above particulars relative to the balance or ſcale beam are duly attended to, it may be made and kept ſufficiently accurate to determine the comparative weight of bodies according to the national ſtandard; which ſtandard, it muſt be acknowledged, is not only exceedingly unſcientific, but ſo precarious, that if the weights in the Exchequer were deſtroyed, they could not be repleniſhed with any degree of certainty:

their unit or root being ſo variable.* The ſociety of arts in London, ſeeing the abſurdity of ſuch a variable foundation to conſtruct ſo material a concern upon, as a national ſtandard of weights, offered a premium of 50l. or their gold medal, to the perſon that could diſcover an invariable and univerſal ſtandard for weights and meaſures. This propoſal coming to my hand; and being deſirous both to oblige ſo reſpectable a body of men, and acquire the credit of ſuch a diſcovery, I have taken the liberty to communicate my thoughts on that matter to them, but cannot yet be informed of their ſentiments concerning it. However, as I am well convinced, that the method I have offered will anſwer the purpoſe (but do not flatter myſelf that a better is not diſcoverable) I think it my duty to lay it before the reader as follows.

FIRST, As all ſublunary objects are mutable, I at once concluded, that the ſubject for this unit or root muſt be a celeſtial body: And as the ſun affords us a meaſure for time, and ſeeing no object ſo ſuitable, I was willing to adapt the ſame great object, to anſwer the purpoſe of furniſhing an univerſal and invariable ſtandard for weights and meaſures. This, to me, ſeemed attainable by the aid of a nice micrometer, on any equinox day; as the apparent diameter of that glorious luminary was on ſuch days equal to all the inhabitants of the earth.

THE

* The unit or root on which all manner of weight is founded in this kingdom, is a grain of wheat taken from the middle of the ear, which every one knows is as variable in ſize and weight as ſheep or cattle. And the unit for lineal meaſure is a barley-corn taken from the middle of the ear, a matter equally exceptionable.

THE apparent diameter of the ſun being accurately aſcertained, would need no further conſtruction to anſwer the purpoſe of an unit or root for the meaſurement of lengths, ſuperficies, and ſolids, of every denomination, as it might be multiplied or divided at pleaſure.

AND as there is a true and ready criterion, well known in all nations, to diſtinguiſh pure gold from that which has alloy of any kind, and from all other metals*: And as pure gold, in every nation, has the ſame ſpecific gravity; a cube or die of ſuch pure gold, whoſe ſides were each exactly the length of the unit, for lineal meaſure, or apparent diameter of the ſun, taken as above, would ſerve as an unit or root for weights of every denomination, as it might be divided or multiplied at pleaſure alſo.

THUS might a ſtandard for weights and meaſures be conſtructed upon a rational and permanent principle, which, every ſix months, might be examined by all nations, if needful; and the abſurd and unphiloſophic ſtandards, which now obtain in this and other nations, be aboliſhed.

THE next ſpecies of mechanical inſtruments that we are to treat of, according to our method, is ſuch as have a tendency to overcome the attraction of coheſion; and of all others yet known, gunpowder is the moſt effectual for that purpoſe. An account of its conſtituent parts, and manner of acting, ſeems there-

* A fuſion with antimony.

therefore requiſite, to inform ſuch readers as have not ſtudied in what manner they may produce the greateſt effects it is capable of; *cæteris paribus*, and well purified

THE ingredients or conſtituent parts of gunpowder are, ſaltpetre, ſulphur, and charcoal; and their proportions, (in weight) to make it as good as may be, are found to be, ſaltpetre 4, ſulphur 1, and charcoal 1, provided they be all good of their kind.

BUT as the judging of the quality of the ingredients of gunpowder is the buſineſs of manufacturers of that article of commerce, rather than the conſumers, the powder-trier ſeems to be better adapted to the generality of mankind, as a criterion, than any other method yet in uſe: And as every kind of that inſtrument is calculated to ſhew the comparative ſtrength of the powder, thoſe kinds which do it with moſt certainty and eaſe, are no doubt to be preferred, eſpecially as they will be the moſt ſimple in their conſtruction.

BUT it muſt be remembered, that the charge for trial ſhould be computed by weight, otherwiſe the ſmall powder might ſeem the ſtrongeſt, altho' it is in general the weakeſt, as it would be equal in weight, and conſequently materials, when it appeared no way equal in quantity by meaſure. Gentlemen that practiſe ſhooting, ought therefore firſt to uſe their powder-triers, and from the determination to adjuſt their chargers, if

if they would effectually avoid danger and waſte. Thoſe who uſe gunpowder for breaking up blocks of ſtone, wood, &c. ought to be guided by the ſame conſideration. Indeed it is impoſſible to reconcile the idea of uſing powder of inferior quality, with common ſenſe, unleſs it be to burn on ſignals or rejoicings.

HAVING mentioned the breaking up of blocks of ſtone, wood, and ſuch like ſubſtances with gunpowder, I cannot help requeſting ſuch artificers, that they, in particular, may uſe the beſt powder, as the manner of charging they are obliged to uſe, is exceedingly expenſive, and the entire ſucceſs of the operation depends on the quality of the powder, compactneſs of the plugging, and the few following peculiar circumſtances, viz. the depth of the bore, its ſize, the ſolidity of the block, and the ſituation thereof. With reſpect to the depth and ſize of the bore, this is to be regulated by the ſolidity, ſize, and ſituation of the block, as to be put no greater diſtance from a free ſide than the charge of powder can eaſily ſever from the block: And if the block is porous, the hold, both perpendicularly and laterally, muſt be moderated, otherwiſe the elaſtic vapour of the powder will make its eſcape through thoſe avenues, without effectually overcoming the adheſion of the block, and ſeparating it as was intended. Whereas, when the block is large, ſolid, and free from obſtruction, the bore ought to be put deep, in order to enable the plugging to reſiſt the force of the powder; and

in

in order to preſerve the ſtrength of the powder, care ought to be taken that it be not bruiſed by the plugging, nor moiſtened in the bore; for bruiſed and moiſtened gunpowder loſes ſtrength as theſe inconveniences obtain, even to its whole effect. Such inconveniences ought therefore to be guarded againſt with the utmoſt ſedulity: And the beſt preſervative I know of againſt bruiſing, is to drill or ſtamp the chamber where the powder is to lodge, with a tool, a ſmall matter leſs than the other part of the bore; and as ſoon as the powder is let down, and made to fill the chamber exactly to the top, put a piece of iron upon it, an eighth of an inch thick, and full as broad as the largeſt part of the bore, with a hole in its middle ſufficient to contain the ſpindle or pricker that forms the touch-hole;* let this piece of iron be let down to reſt upon the top of the chamber, and juſt to touch the powder, and beat the plugging gently until it is two or three inches thick, and the powder will then be out of danger of being bruiſed, however hard the plugging is beat afterwards. It will be neceſſary, however, to keep ſtirring the ſpindle or pricker that forms the touch-hole frequently; otherwiſe, notwithſtanding it may be finely tapered and poliſhed, it will become ſo fixed to the plugging, that it will either ſtick in, or break, and then the whole expence is in vain.

* Half a dozen of ſuch pieces of iron may be afforded for a penny.

It is alſo neceſſary to let the point of the pricker or ſpindle deep into the powder; becauſe when the priming is let down cautiouſly to the bottom, the flame will fire the whole charging inſtantaneouſly, and thereby produce the greateſt effect poſſible.

These particulars duly attended to, will prevent many inconveniences, beſides that of bruiſing the powder; and if there is the leaſt ſuſpicion of the bore moiſtening the powder, it muſt be incloſed in cartridge paper, and diſcharged as quick as may be. But ſhould the bore be more wet, the cartridge muſt be ſmeared over with pitch and tallow melted together, and a pipe to convey the priming inſerted therein; which ought likewiſe to be well luted with the above compoſition at the place of inſertion, in order to bar the leaſt moiſture approaching the powder, as the conſequence of water mingled with the powder would ruin the blaſt or mine.

The next mechanical inſtrument, with reſpect to power and effect, uſed in overcoming the attraction of coheſion, is the wedge, and ram or mallet; the theory of which I have in ſome meaſure explained in a preceding page, need therefore only intimate ſuch particulars as tend to explain the nature and effect of the ram or mallet, and manner of applying the wedge to advantage. Previous to which the few following particulars ſhould be attended to: Firſt, is the body that is intended to be divided by the mallet or wedge, wood, ſtone, or metal; if it is wood, both the mallet and wedge muſt be uſed, and

if it is twiſted and knotty, and a ſtreight diviſion is intended, the firſt ſet of wedges ought to be placed within a ſmall diſtance of one another, and to be ſteeled and ground to a ſharp edge, and of a gradual taper to the head. The next ſet, if there is occaſion to uſe two ſets, ſhould be of a leſs taper; and if made oval in the body, they will do rather more execution with the ſame force, and will be eaſier drawn than if flat.

If it is ſtone that is to be divided, is it of a hard or ſoft texture; and is it a ſolid maſs, or does it conſiſt of lemela, and is it intended to be laid in regular or irregular pieces. If it is hard, holes ought to be made of ſuch a depth as to admit the points of the wedges without interruption to the laſt, and to be made ſo large as to admit the point of the wedge and a ſlip of iron on each ſide of it; and if the pieces are to be thrown off regular, ſeveral wedges muſt be uſed, eſpecially if the pieces are large; in no caſe where the cut is intended to be ſtreight, leſs than two wedges ought to be uſed.

If the ſtone is ſoft and conſiſts of regular lemela, a tapering groove is to be formed by the point of a pick or hack to plant the wedge or wedges in; and if the wedges are ſquare on the face, and the groove ſo deep as to admit the face without interruption, until the ſhoulders of the wedge are well gripped by the ſides of the groove, in order to prevent their ſtarting out when the mallet is applied, the ſquare face will

will greatly aſſiſt the ſhoulder of the wedge in throwing off the piece; for at the ſame time that the ſhoulders ſtretch the pieces on either ſide, the face, by making an effort to ſtamp down the lemela or plank before it, very much increaſes the concuſſion or ſhake that breaks the adheſion of the lemelas that are in contact with the wedge.

THE next thing to be attended to in the above buſineſs, is the weight and ſhape of the mallet, either for driving wedges or breaking a block of ſtone or metal by its ſtroke ſimply. With reſpect to its weight for the purpoſe of driving wedges, it is to be regulated by the ſize of the wedges it is to be applied to, and their ſize by the work they are to perform, always avoiding an extreme, eſpecially on the greater ſide; for the ſmaller the quantity of matter contained in the *wedge*, provided *it* be ſufficiently ſtrong to bear the ſtroke of the mallet, &c. the greater effect the ſtroke will have: the effect being always in direct proportion to the quantity of matter contained in the impelling bodies, when their velocities are equal: And if one body is at reſt (as is the wedge) and the other in motion (as is the mallet) then is the effect or energy of the ſtroke given by the moving body or mallet, as its velocity multiplied by the quantity of matter it contains. Hence it is certain, that the larger the mallet is (provided the perſon that works it be able to direct it ſteadily) and the ſmaller the wedge is (provided it is able to bear the impetus of the ſtroke and reſiſtance of the block) the greater the effect will be, *cæteris paribus*.

THE diſcuſſion of this principle anticipates almoſt every thing I had to advance concerning the *vis inertiæ* of matter, as the *vis inertiæ* is the foundation of the principle itſelf; as may be demonſtrated by the following ſimple experiment, viz. Put a piece of ſtone, metal, or any other ſubſtance of any weight, ſufficient to overcome the friction, to the end of a cord ſuſpended upon a wheel or pulley, and it will keep deſcending with an accelerated velocity as far as the cord will admit: But if the deſcending body is ſtopped, and an equal quantity of matter is put to the oppoſite end of the cord, the deſcending weight comes to reſt. Hence it follows, that no more force is required to prevent motion in the firſt inſtance, than is neceſſary to give motion; or that action and reaction is equal: And that matter is therefore altogether paſſive and indifferent either to motion or reſt when placed in free ſpace, or even in equally reſiſting mediums, if every other circumſtance is equal. It alſo follows, that as the deſcending body acquired an accelerated motion in deſcending, that ſome extraneous cauſe muſt have obtained, which cauſe we know is the attraction of gravitation; as the increaſe of motion thereby occaſioned exactly coincides with its laws, viz. The increaſe of motion is exactly as the ſquare root of the ſpace paſſed through. For inſtance, if the weight has deſcended through 25 feet, it will have an effect as 5; if it has deſcended through 16 feet, it will have the effect of 4; and if it has deſcended 9 feet, it will have the effect of 3; and if only through 4 feet, the effect of 2, &c.

THIS reſult teaches us, that artiſts who employ the battering ram avail themſelves greatly, by elevating it to the utmoſt limit: And alſo, that the talleſt labourers, if they are equally capable in other reſpects, have the advantage of the ſhort ones at the uſe of the mallet or cavel, as they can raiſe it to a greater height.

WHAT obtains with reſpect to the weight and other particulars that have been mentioned relative to the driving of wedges with a mallet, does alſo obtain in the uſe of that inſtrument when applied to break a block of ſtone or metal to pieces without wedges; that is, by the concuſſion occaſioned by the impetus or ſtroke of that inſtrument. The ſhape however ought to be different; the mallet that is for driving wedges requiring the ends ſquare; and that which is uſed to break the block by its ſtroke ſimply, flatted ſomewhat like a wedge, yet left ſufficiently ſtrong to ſupport the labour equally with its other parts; and whether the mallet be for the one uſe or the other, let the ends be as ſhort as it is poſſible for them to be, to contain the proper weight; and if for driving wedges, let it be a double truncated cone, whoſe apexes are half their baſis; as that figure meets with (nearly) the leaſt reſiſtance in paſſing through air of any denſity. See plate V. fig. 8. And if for ſplitting or breaking blocks of ſtone or other ſubſtances ſimply by the force applied to it, let it be a double cone, vide fig 9. ib.

THE

THE next article, according to the method, to be treated of, is, the elaſticity of bodies; and the chief impediment which that property of bodies occaſions, conſiſts in the three following particulars viz. 1ſt. The recoiling of mechanical inſtruments, immediately after colliſion, that are elaſtic, or ſtriking againſt other elaſtic bodies that are of ſuperior magnitude, or ſo fixed as to remain at reſt after colliſion. 2d. The recoiling of the parts of machines, &c. that are uſed as levers, or parts of connection between the moving power and body to be moved. 3d. The reſiſtance of flexible elaſtic bodies, ſuch as hemp, flax, wool, &c. &c. when there is occaſion to ſtow them in ſhips or any other veſſel, warehouſes, or other reſervoir for ſuch commodities.

WITH reſpect to the firſt impediment, it often obtains in huſbandmen's concerns, much to their injury, particularly in the uſe of the plough and wheel carriage. For when the coulter and ſhare, or any one of them, by the action of the cattle which work the plough, ſtrikes againſt a ſtone of ſuch magnitude and hardneſs, that it does not yield to the ſtroke, both the cattle and materials that connect them to the plough, as well as the plough itſelf, meet with a ſhock or reaction nearly equal to the efforts of the cattle to get forward. This ſhock is not to be regarded as a mere ſtop or halt of the inſtrument and cattle, but as cauſing the whole in the firſt moment of contact to recede with nearly the ſame velocity

velocity they were proceeding with. Hence, although the cattle do not ſeem to be torn back from their ſituation, yet their ſhoulders and other parts that are in contact with the materials that connect them to the plough or carriage, are obliged to yield to the reaction; a circumſtance which much impairs the muſcular force of thoſe uſeful creatures, as well as their agility and ſhape.

THE true remedy for this ſort of inconvenience, is ripping or quarrying out of the ground, the ſtones that give ſuch oppoſition. But as the ſmaller ſtones (even ſuch as would be too tedious to remove) in droughty ſeaſons, become obſtacles to the plough, I would adviſe huſbandmen to put double collars or brighams filled or ſtuffed with very elaſtic materials, ſuch as curled hair, &c. before their horſes ſhoulders, and uſe thick cloſe laid rope in lieu of iron chains at that ſeaſon, as they would greatly abate the reaction upon the cattle and ſolid parts of the plough by yelding to the ſkock. However, if huſbandmen would condeſcend to be at a little more expence to remove this very capital inconvenience, I would alſo recommend their placing ſuch an inſtrument as fig. 10, plate V. to the end of the beam; as that inſtrument would not only prevent that deſtructive ſhock to the wholes muſcular ſyſtem of the cattle* employed in working the plough, but in a great meaſure prevent the deſtruction of the inſtrument itſelf, which inevitably awaits ſuch violent ſhocks.

* If bullocks are put to plough or carriage, the ſome precaution ought to be uſed.

THE inſtrument conſiſts of a tube or cylinder, *a*, *a*, *a*, *a*; in which is incloſed a ſpiral ſpring of conſiderable ſtrength, and the bolt or neck D ought to be proportionably ſtrong, an ought to be made thicker behind than at the end where hook B is connected, in order, as it lengthens by any extraordinary reſiſtance or effort of the cattle, the end or hook B may be puſhed downwards, and thereby counteract the effect that the increaſe of length in the tow chain muſt occaſion. And as an increaſe of length of tow chain occaſions the plough to ſink deeper into the land, the bolt or neck D ought not only to act as a wedge againſt the upper ſide of the mortice in the end of the caſe or cylinder it iſſues from, but the caſe itſelf muſt be ſo fixed on the end of the beam, as to remain always at one height. The method of doing which I muſt leave to the management of the ſmith and wright, who I think may readily complete it.

THE uſe of this inſtrument, as I have already ſaid, is to take the ſhock that is occaſioned by the recoiling of the plough after it has impinged on ſome elaſtic, quieſcent object, from the cattle; and ſo prevent the diſtreſs ſuch violent and unnatural labour occaſions: And this it will do by yielding to the ſhock in ſome meaſure. But I beg leave to remind the reader, that I rather recommend ripping up the large ſtones, and taking land in a ſtate between moiſt and dry, to avoid the little ſtones, than any other method whatever, as by ſo doing

doing, we eaſe the cattle, ſave the tackle of every kind, and make the beſt work at the leaſt expence; every thing elſe being equal.

THE beſt way to prevent the ſhocks, which wheel carriages are liable to, from ſtriking againſt ſtones and other elaſtic obſtacles, is to remove ſuch obſtacles if poſſible: where it cannot be done, higher wheels muſt be uſed; but the reaſons for this will be better underſtood when we come to the principles of wheel-carriages. As to the ſecond remark on this head, viz. the ſpringyneſs of levers, or other parts of machines, altho' the inconveniences which they occaſion are very great in the axletrees of mills, ſtarts of gins, the beams of fire-engines, and every thing of that kind; yet the remedy is very ſimple, viz. to make ſuch parts of a ſtrength ſuperior to the ſtrain of the work. And this may ſometimes be done at a leſs expence both of wood and friction, by ſtaying properly, than by making the members ſo exceedingly ſtrong and heavy, as to be incapable of having their parts thrown into a ſtruggle. However, let this ſtruggle between the power and body that is to be moved, be prevented either the one way or the other; for the hazard (ariſing from this cauſe) of breaking a machine or engine, and alſo of deſtroying the moving power, particularly if it is animal agency, is too great to be overlooked.

THE third and next particular on this head, is, the reſiſtance of flexible, elaſtic bodies; ſuch as flax, hemp, wool, &c. &c.

And as the inconveniences which theſe occaſion are chiefly the want of room in package, &c. they will be eaſieſt got over by compreſſion: And of all other mechanical inſtruments, the ſcrew is beſt calculated to do the work: As it may not only be made to have immenſe power by applying the lever to it, but retain the advantages it gains, with the greateſt ſimplicity. It will, however, alſo be neceſſary, whenever any of thoſe, or ſuch like commodities, are to be cloſe packed, to have them dry and cold; they being all of the nature of ſpunge, and conſequently imbibe moiſture, and thereby become leſs compreſſible.

Now, as heat muſt cauſe even the natural moiſture, which is contained in the capillaries of ſuch ſubſtances, to expand: cold muſt, on the other hand, condenſe it. It therefore appears reaſonable to conclude, that compreſſion of this ſort ought to be performed in cold places.

The elaſticity of rope in winding round a roll or cylinder, is alſo an impediment to mechanics. And as the reſiſtance thereby occaſioned, always increaſes as the diameter of the roller decreaſes, ſuch rollers ſhould not be made of leſs diameter than two or three feet (if it can be afforded;) as after that the reſiſtance of the largeſt rope in uſe, unleſs very much ſtrained by tenſion, is very inconſiderable.

Having ſhewn in what reſpects elaſticity is moſt detrimental to mechanics, and how to overcome it; or at leaſt reduce

it

it to its loweſt terms: We ſhall next take a brief ſurvey of its uſefulneſs and aſſiſtance to mechanics.

FIRST then, let us attend to that ſtupendous and unparelleled piece of mechaniſm, the Steam Engine. The effect of which (great as it is) is derived from this cauſe, by the action of fire on water, in the following manner, viz. A kettle or boiler is provided of ſuch ſize as will ſupply the demand of the engine with ſteam, when ſufficiently heated: Conſequently, a fire muſt be provided adequate thereto. The ſize, ſhape, manner of placing boilers, ſo as they may have the greateſt effect at the leaſt expence, and alſo the manner of applying fire to that purpoſe, are conſiderations well deſerving particular attention: But as the diſcuſſion thereof in ſo particular a way as the ſubject deſerves, would far exceed the limits that can be aſſigned to that purpoſe, in this publication, this general account muſt ſuffice at this time.

THAT water ſufficiently heated, doth furniſh ſteam, or an elaſtic vapour, none can doubt. And the theory of it is this: Water is compoſed of globular particles or atoms, which, altho' they be exceedingly ſmall, will conſtitute a ſeries of cavities, or ſmall interſtices, where the particles cannot touch, or be in contact. This we need not doubt of, as the particles are all of one ſize, and alſo incompreſſible (unleſs by freezing) as the Florentine experiment, and many others clearly demonſtrate.

Now as thoſe interſtices or cavities neceſſarily muſt exiſt; and as water is known to contain both fire and air, as well as all the other elements, we need not doubt of their occupying thoſe interſtices. And, moreover, as thoſe elements are known to expand in proportion to any degree of agitation; it follows, that the primitive particles of water may be thrown out of the ſphere of their attraction by ſuch expanſion, and thereby make an effort to occupy more ſpace than they did before; and that this effort keeps pace with the energy of the cauſe, viz. the degree of heat applied to the boiler.

When the ſteam or vapour thus generated, is become ſtrong enough for working the engine, which is known by its whiteneſs, but more exactly by its raiſing a valve loaded with the atmoſphere, and as much more weight as the engine requires the ſteam to be ſtronger than the preſſure of the atmoſphere upon the piſton of the cylinder; it is then let paſs into the cylinder by opening a cock ſuited to the ſize of the cylinder, &c. The hot ſteam being thus let into the cylinder, the piſton will be elevated to its limits as ſoon as the parts are properly heated, and the capacity of the cylinder filled with ſteam.

Here it is neceſſary to inform the reader, that other means are uſed by moſt engine-men, to cauſe the piſton to gain the firſt aſcent or elevation, viz. by making the oppoſite end of the beam, or regulator (as it is called) ſo greatly ſuperior in weight

. to

to the piſton and the end of the beam it is connected with, that the oppoſite end always preponderates with immenſe force when the engine ceaſes to work; a circumſtance that gives the balance greatly againſt the acting powers.

To enter largely into the diſcuſſion of this particular, may be thought foreign to the deſign of this compendium of mechanics: But as expoſing ſo fatal an error in the conſtruction of a machine of the firſt conſequence to the nation, may have a tendency to remove the inconvenience, I beg the reader's indulgence for offering a few lines to that purport.

First then, in order to prove that making one end of the beam heavier than the other, is an error, we muſt attend to the nature and application of the acting powers, and diſtinguiſh them from the mere paſſive materials that are employed as parts of the machine only.

Now as the piſton never makes an effort to deſcend in the cylinder, after being elevated, until a jet of cold water is mingled with the ſteam; it follows, that the ſteam is condenſed by the cold water, and that a vacuum enſues, and that ſuch vacuum will cauſe the atmoſphere to act on the top of the piſton, in proportion to the weight of a column of the atmoſphere of equal diameter to the cylinder, provided the vacuum is complete: If the vacuum is incomplete, as it unavoidably muſt be, then will the degree of preſſure on the top of the piſton be as the exceſs only; which, in engines, ſeldom amounts to more than eight pounds to an inch.

FROM this data, the ſize of the cylinder is to be calculated; and, from what has been ſaid, it is ſelf-evident, that the deſcent of the piſton is owing to the preſſure of the atmoſphere on its top. This point being aſcertained, let us, in the next place, enquire into the cauſe of the aſcent of the piſton.

THIS, to real mechanicians, no doubt, will appear rather an idle curioſity, than a neceſſary enquiry; as they muſt know it is the elaſtic force of the ſteam that elevates the piſton. But as a contrary and moſt dangerous opinion has been long entertained among engineers, even where more ſteam engines are uſed, than in any quarter of the kingdom; and as that opinion has occaſioned much unneceſſary expence, I think a demonſtration of its fallacy will not be unacceptable to the reader.

FIRST then, if the piſton has deſcended in the cylinder with a convenient velocity, as low as the cheeks will permit it, or the mechaniſm and ſtroke of the pumps require, as ſoon as the ſteam was condenſed, it is clear, from the laws of motion, (viz. that action and re-action, in contrary directions, are equal, *cæteris paribus*); that the preſſure of the atmoſphere on the top of the piſton, was ſuperior to the reſiſtance of the column of water the pumps were raiſing, the friction of all the parts in action, the weight of the pump rods, and every particle of matter connected with the oppoſite end of the beam. This being the caſe, and the column of water, which occaſions at leaſt 8-10ths of the whole reſiſtance, ceaſing to act

act as ſoon as the piſton arrives at its loweſt deſcent; and yet the ſame quantity of preſſure of the atmoſphere remaining on the top of the cylinder, as it unavoidably does, the piſton would for ever remain in that ſituation, unleſs ſome agent, at leaſt as powerful, intervened. It follows, therefore, that if only one agent is employed to raiſe it, and if it ariſe with all the weight upon it, and with as great velocity as it deſcended, that that agent is the cauſe of its aſcent or riſing; and that the agent exerts a force at leaſt equal to the preſſure of the atmoſphere on the top of the piſton when ſuch piſton deſcended.

It only remains now, to demonſtrate what this agent is: And as no ſort of viſible nor inviſible agent is introduced, (unleſs it be introduced magickly) except ſteam; no doubt can remain with any perſon, that the ſteam is the cauſe of the aſcent of the piſton.

Having thus clearly proved, that the ſteam is the firſt mover in a well conſtructed ſteam engine; and that the preſſure of the atmoſphere obtains in proportion to the quantity of vacuum that is made in the cylinder, as a re-acting or ſecondary cauſe; and laſtly, that the alternate motion of the piſton, pump rods, &c. &c. is begun and kept up by their agency; I ſhall next explain how thoſe powers, viz. the ſteam, as the antecedent cauſe, and the preſſure of the atmoſphere, as a conſequent of the condenſation of the ſteam, has the beſt chance

of

of doing the moſt buſineſs at the leaſt expence. And the principle is ſimple and eaſy; for if the ſteam and atmoſphere are to act alternately, all the parts that neceſſarily belong to either end of the beam, together with the beam itſelf, ought to be put in equilibrio before ſtarting;* and the center of motion of the beam kept as much above its center of gravity, as to make it vibrate in ſome meaſure, like the pallats of a clock with a royal pendulum.

THIS indeed is as oppoſite to the preſent practice as eaſt is to weſt; for the gudgeon or fulcrum is uſually put below a ſtraight beam; whereas, it ought to be placed at *a*. Vide fig. 11, plate V. *b*, *c*, are the circular heads of the beam, *e*, *e*, *e*, *e*, four iron ſtays to ſupport them; and *d*, *d*, *d*, *d*, four ſtrong ſtraps of iron, which, with as many bolts, will keep the whole together.

THIS conſtruction of the beam of a fire engine is very different from thoſe generally in uſe, but need be no greater expence; as a crooked tree may as eaſily be had as a ſtraight one: Beſides, the crooked beam ſtayed as the figure indicates, will be ſtronger than a ſtraight one of the ſame ſubſtance. And with reſpect to the advantage of the engine, there cannot be a doubt of its ſaving many tons of force every minute the engine goes, at the trifling expence of a few forcing chains.

THERE

* OTHERWISE, the engine is in the ſame predicament with a pair of ſcales that are unequal in weight. The inconvenience of ſcales being unequal in weight, occaſions the merchants, &c. to add a counterbalance; but ſhould ſuch counterbalance amount to a ton or two, (and it is often more in a engine) it would be troubleſome even to the merchant to load the lighter ſcale: But far more ſo is it to the proprietor of an engine, as the counterbalance can only be made by the atmoſphere: Conſequently, much larger cylinders and boilers muſt and are uſed than need be.

THERE are yet ſeveral denominations of elaſticity which are ſerviceable to mechanics, and to mankind; ſuch as the elaſticity of air, the elaſticity of ſprings, &c. yet remaining to be explained in this work. But, as entering minutely into thoſe matters, would require much greater ſpace than can be here allowed, ſhall content myſelf with a general remark on each, viz. 1ſt. That the elaſticity or ſpring of the atmoſpherial air, is never leſs than its preſſure; but capable by rarefaction of being increaſed to any degree beyond it. 2d. That the elaſticity of ſprings made of any particular metal, for inſtance, ſteel, is conſtantly as the degree of compreſſion of its pores, *cæteris paribus*. Hence it is, that metals by being hammered, or plunged into cold water, when hot, become more elaſtic.

THE next ſubject we are to diſcuſs, according to the method, is, the preſſure or impulſe of fluids, as impediments to mechanics: And ſhall begin with the preſſure of water againſt banks or reſervoirs. But to form a true idea of this impediment, we ought, in the firſt place, to learn by what univerſal law the preſſure of fluids can be eſtimated: And as this law is already ſufficiently authenticated by experiment, we need only recite its properties upon this occaſion.

THE firſt and great property is, that their preſſure is as their height, without reſpect to quantity; for inſtance, if a tube or pump, one hundred feet high, and only three inches diameter,

is filled with water; the water has as much preſſure againſt the ſides of that tube or pump, as if it were one hundred feet diameter.

THIS peculiar property in fluids is called the hydroſtatic paradox; and is one of the many inſtances which nature affords, to prove beyond controverſy, that nothing ſhort of infinite wiſdom and power have been employed to put orignal matter in the ſtate it now is; for had not this law been given to fluids, all ſeas, rivers, or collections of water, by whatever name they are or might have been called, muſt have been exactly of one magnitude; otherwiſe they could not have diſembogued themſelves. But in the preſent ſtate of things, it is well known, that be the rill ever ſo ſmall, and the ſea ever ſo large into which it diſcharges; if the ſurface of the rill is upon a level with the ſurface of that great water, there is a balance, and the rill empties itſelf without difficulty.

THE ſecond great property by which the preſſure of fluids is to be eſtimated is, that the quantity of preſſure at any altitude, is to the quantity of preſſure at a greater or leſſer altitude, exactly as the ſquare roots of the numbers which expreſs thoſe altitudes, viz. If the preſſure at the bottom of a tube four feet high, be ten ſtone (or any other denomination of weight) the preſſure at the bottom of a tube nine feet high, will be 15 ſtone. But as this matter cannot be made

too

too plain, I ſhall give the operation; and alſo an example or two arithmetically.

THE ſquare root of 4 being 2, and the ſquare root of 9 being 3; we ſay, if 2 give 10, what will 3 give.

2 : 10 : : 3

10

2)30(15 *Anſw.*

2

10

10

..

IF the queſtion ſhould be put thus: The preſſure of a column of water 16 feet high, being 26 ſtone; what will the preſſure be of a column 36 feet high: the ratio or proportion being as the ſquare root of the reſpective heights. The ſquare root of 16 being four, and the ſquare root of 36 being 6; ſtate it thus:

4 : 26 : : 6

6

4)156(39 *Anſw.*

12

36

36

..

LITTLE elſe interpoſes to make this calculation any how difficult, except the extraction of the ſqare root; and as any common ſchool-maſter can aſſiſt in that, I think, on that account, as well as its being rather foreign to our plan to enter upon ſuch a ſubject, that what has been ſaid relative to the above may ſuffice. However, as moſt readers would rather wiſh to be able to help themſelves than trouble others, ſhall, for that purpoſe, inſert the following table; which is new, and not incurious.

Sq. Root.	1	2	3	4	5	6	7	8	9	10
Number.	1	4	9	16	25	36	49	64	81	100
Sq. Root.	11	12	13	14	15	16	17	18	19	20
Number.	121	144	169	196	225	256	289	324	361	400
Sq. Root.	21	22	23	24	25	26	27	28	29	30
Number.	441	484	529	576	625	676	729	784	841	900

IN the above table, the root of every ſquare number, from 1 to 900, is to be found by inſpection only: And the table may be extended to any length, by multiplying numbers into themſelves, thus: If the number is deſired that has 31 for its root, multiply 31 by 31, and the product (961) is the number ſought.

BUT what is more curious, and not leſs uſeful in this table is, that the root of any intermediate number may be found by it much ſooner, and equally as true, as by extracting the ſquare

ſquare root in the uſual way; for inſtance, if the ſquare root of 5 is required, nothing need be done but obſerve how many parts or numbers are contained between the two ſquare numbers next to 5, viz. between 4 and 9, which is found to be 5: hence, the root of 4 being 2, and the root of 9 being only 3; the root of 5 will be 2 and $\frac{1}{5}$ of an unit; the root of 6, $2\frac{2}{5}$; the root of 7, $2\frac{3}{5}$; the root of 8, $2\frac{4}{5}$. The ſame rule holds for any other intermediate number, as we ſhall prove by another example.

If the root of 82, or any number, or all the numbers between 81 and 100 are required; the anſwer is thus moſt readily obtained: The difference between 81 and 100 being 19, and the root of 81 being 9, and the root of 100 being 10; each of the intermediate numbers muſt be 9, and as many of thoſe 19 parts as correſpond to their places reſpectively, viz. the root of 82 will be $9\frac{1}{19}$; the root of 83, $9\frac{2}{19}$; 84, $9\frac{3}{19}$; 85, $9\frac{4}{19}$; 86, $9\frac{5}{19}$; and ſo on.

The preſſure of fluids in different altitudes being diſcovered, that and their penetrability ought to make all people, that have thoſe impediments to combat, provide effectually againſt them, by allowing proper materials, and a degree of ſtrength correſponding to the degree of preſſure any particular altitude requires.

Thus, if a reſervoir or pump is 100 feet deep, the ſides of ſuch reſervoir or pump will require ten times the ſtrength near

near its bottom that it requires near its top to ſuſtain the preſſure: I mention this circumſtance, to remind artificers in that way of buſineſs, that by attending to this idea, ſome conſiderable ſavings may be made; as uſing an equal weight of materials near the top of pumps, &c. that is neceſſary near their bottoms, is not only exceedingly unmechanical, but exceedingly waſteful.

We have in ſome meaſure already explained the theory of the preſſure of the atmoſphere, when we diſcuſſed the principle upon which the ſteam engine is properly conſtructed: Shall therefore only add the few material particulars that have not been taken up relative thereto, viz.

First, That the quantity of preſſure has never hitherto, and probably never will exceed 15 lb. on the ſurface of an inch, when the vacuum has been the moſt perfect art is equal to, and the atmoſphere in its heavieſt ſtate.

Second, That as it has often leſs weight or preſſure, and almoſt continually varying, that ſome account may be made of ſuch variations relative to a perpetual movement.

Third, That as this preſſure aſſuredly will take place, in conſequence of the air or atmoſphere being driven out of any compartment on or near the ſurface of the earth; it will become an impediment to mechanical effects, that require an equal

equal medium to be able to produce equal effects; for inſtance, if a roller, the wheels of a waggon, or any other wheel carriage, is preſſed into a clay, or any other tenacious ſoil, in ſuch manner as to exclude the air; the conſequence would be, that the preſſure of the atmoſphere would immediately act againſt the acting power, in proportion to the quantity of vacuum generated by ſuch means: And we need not go beyond an experiment with a walking ſtick ſtuck into ſuch a ſoil, or the boys cleavers, to be fully convinced of the truth of this aſſertion.

It is equally certain, that water has a ſimilar effect: and hence it is, that ſhips, and even human bodies, ſtuck in mud at the bottom of deep waters, cannot be diſengaged but by immenſe force.

Having taken notice of the moſt conſiderable effects of preſſure, as an impediment to mechanics; I ſhall now conſider the effects of preſſure and impulſe as far as they are aſſiſting to mechanical purpoſes; particularly reſpecting the turning of mills, ſailing of ſhips, &c.

First then, with reſpect to the turning of wheels by water, the following axiom is to be attended to, viz. That the wheel ought to proceed with a velocity of about one-third of the velocity of the water that turns it, if the greateſt effects

are

are produced. And the velocity of the water may be aſcertained with preciſion, as follows, viz. As all bodies near the ſurface of the earth are found by experiment, as well as theory, to deſcend or fall at the rate of 16 feet 2 inches in the firſt ſecond of deſcent, 48 feet 6 inches in the next ſecond, and 80 feet 10 inches in the third ſecond; and ſo on in that proportion, until the diſtance or quantity of deſcent far exceeds any practical occaſion: hence, we are to take the altitude or perpendicular height of the ſurface of the water in the head above the ladles of the wheel whereon it is to impinge, and compute its velocity by theſe proportions. Secondly, That if it is an over-ſhot wheel, the water ought to be conveyed to it by a trough of at leaſt 4 feet long, and of an equal width from the reſervoir to the wheel; for if it is wider at the end next the wheel, than at the end next the reſervoir, the water will loſe height: and if it is ſtraiter, the water will loſe power, by being wire-drawn, if I may uſe the expreſſion.

It ought, therefore, to be conveyed in an uniform column, and to ſtrike the ladles, or boxes of the wheel, at right angles. (See fig. 12.) And if the trough is laid to an angle of between 45 and 46 degrees, (ſee the line A B, ib.) and the radius of the wheel anſwers the ſame angle, the greateſt effects may be expected.

With reſpect to the preſſure or force of wind in turning mills, the following particulars are to be obſerved, viz.

First, That the wheel (ſails) of a wind-mill is capable of doing the moſt work, when it moves with one-third of the velocity of the current of air or wind that actuates it.

Secondly, That as the force of the wind applied to the ſails, in a direction which makes them meet perpendicularly, would tend to overturn the mill, but have no tendency to make the axletree or machinery revolve: In order, therefore, to make it have the latter effect, the ſails muſt be laid to make an angle with the wind or current of air; and the angle which anſwers beſt is between fifty and ſixty degrees.

It is to be obſerved, however, that this angle is not the moſt proper at every part of the ſails, but only where their center of gravity lies; or at *c*, *c*, *c*, *c*, fig. 13, plate V. for if the arms are about 46 feet long*, the angle at the extremity or outer end, ought to be above 70 degrees; and the angle of the inner end or that next the axletree, not more than 47 degrees: And as mortiſing the arms, in a manner ſuitable to the variation of the angle from end to end of the ſail-frames, greatly reduces their ſtrength; if, therefore, the frames were compoſed of thin iron bars, inſtead of wood ones, and thoſe bars rivetted or ſcrewed on the face of the arms, the plane of the ſail would

* Wind mills are often made with ſhorter arms; but mills that have either heavy or conſtant work, ſhould not be ſhorter; as the arms act as levers, and thereby gain power by an increaſe of diſtance from the axletree. They ſhould not, however, exceed 50 feet.

be better, and the frames much more durable; nor would the extraordinary expence be at all conſiderable.

I have alſo found, that ſail-frames, made in the manner repreſented in the above figure, give the mortiſes in the axletree, and themſelves, the leaſt ſtrain of any other form: nor are they inferior to any other form for effect.

THE force of wind on the ſails of ſhips, is alſo derived from the angular poſition of the ſails, in every caſe; except when a ſhip goes before the wind: And unleſs a ſhip is very long, occupies a great extent of canvas, in the mode ſhewn in fig. 14, has a good breeze, and the ſails ſtretched as plain as poſſible, ſhe cannot go to point A, fig. 2 *ib.* with the wind blowing from any point nearer thereto than point B or C; unleſs ſhe go zig-zag.

THE rudder of a ſhip has likewiſe its effects, by being laid to an angle with the keel of the ſhip; and that effect will be greateſt when the angle is 45 degrees and 44 minutes of a degree, every thing elſe being equal.

WITH reſpect to reſiſting the force of wind, no figure anſwers that purpoſe better than a circular cone: hence, if it ſhould be thought proper to erect a ſpire, either for ornament, or with intention to attract and carry off lightening from

from any ſet of buildings, magazines, &c. (which ſuch an erection will effectually do, if ſituated near enough to, and carried to a ſufficient height above them, and furniſhed with proper conductors.)

If, therefore, the building of ſuch a column or ſpire is in contemplation, no ſhape will ſo effectually reſiſt the efforts of wind and ſtorms as the circular cone (ſee fig. 15, plate V.) And if the ſpindle of the vane is pointed, and likewiſe the vane itſelf, as in the above figure; and the ſpindle bent to the out-ſide of the ſpire as ſoon as it has ſufficient faſtening in the truck about *c*, per the above figure; from which bend or projection to the out-ſide of the building (taking care to make the bend turn downward) a piece of iron about three-fourths of an inch diameter is to be continued down the out-ſide of the wall, as *a*, D, until it dip its point into the earth, or a pool of water (which is better) below the foundation, by which means the lightening will be carried off without injuring the building.

It will be ſtill more effectual, if the ſpire is very high, to throw a hoop of iron of the ſame ſubſtance of the conductor round the ſpire, as at B, per the above figure, with four points, ſuch as *a* 2, per figure, ſtuck into it, in order to attract the clouds that may be driven toward the ſpire at that height; and as this hoop has communication with the deſcending

conductor, the lightening which is there collected will be alſo diſcharged at point D.

THE reſiſtance of water and air is alſo ſerviceable to mechanics, in as much as by ſuch reſiſtance the feathered tribe are able to fly; and fiſh, ſhips, &c. are made to ſwim. I ſhall, therefore, intimate to the reader ſome of the principal data relative thereto.

FIRST, The cauſe of bodies ſwimming on fluids is, that ſuch bodies are of their own nature ſpecifically lighter, bulk for bulk, than the fluid they ſwim in, as is the caſe with cork.

SECONDLY, Or that their ſurfaces are ſo extended, as to make ſpace anſwer for levity; as is the caſe when tin, copper, and other metalic ſubſtances are made to ſwim on water. The very ſame reſult obtains, when ſhips heavy loaden ſwim on rivers or ſeas.

IT is obſervable, however, that ſhips draw leſs water in ſalt than freſh water; and the reaſon is clear and natural, viz. Becauſe ſalt water is heavier than freſh water; conſequently, the ſhip cannot diſplace ſo much of it as of the freſh water.

FROM this inſtance, and innumerable experiments, as well as theory, it appears manifeſt, that ſwimming bodies diſplace ex-

exactly ſuch a quantity of the fluid they ſwim in, as would counterpoiſe them in an oppoſite ſcale: and theſe are the fundamental principles of bodies becoming buoyant or ſwimming.

Now if bodies ſwim only by being either ſpecifically lighter, or artificially ſo, than the fluids they are immerſed in, it muſt follow, that bodies ſpecifically heavier, and not made artificially lighter than the fluids they are immerſed in, muſt ſink therein. Hence it is that ſhips, although they are abundantly buoyant when the water they ſwim on is kept out of them, ſink when they become ſo filled with it, (or any other body) as to overbalance or outweigh a column of it exactly their own bulk. I ſhall only detain the reader on this ſubject, until I explain two things which naturally ariſe from what has been ſaid, and ſeem ſomewhat paradoxical.

FIRST, Why water, which is no heavier than the circumambient water, and communicates with it, and conſequently can weigh nothing, ſhould cauſe a ſhip to ſink.

SECONDLY, Why human bodies have ſunk in water, ever riſe again of their own accord. The reaſon for the firſt, namely, why a ſhip, by having the equilibrium deſtroyed by water, which communicates with the circumambient water, ſinks, is two-fold. Firſt, if the materials of the ſhip taken together, are heavier than water, and conſequently only became buoyant by art,

art, as above premiſed, ſhe muſt ſink, when the cauſe or art is deſtroyed. Secondly, that if the materials of the ſhip, taken together, are, in ſome meaſure, buoyant on water, the cauſe of her ſinking is, that that meaſure of buoyance lies ſomewhere between the bottom of the ſhip and the ſurface of the circumambient water: For if the ſhip was ſo buoyant as to ſwim, after the water in her was as high as the circumambient water, there could not remain a poſſibility of ſinking her. And hence it is that ſhips freighted with fir, timber, &c. ſwim with their holds full of water.

THE reaſon why human bodies, &c. that have ſunk in water, ever riſe again of their own accord, is, that ſuch bodies in nine or ten days, more or leſs, as the heat of the water and ſtate of the bodies promote fermentation, become ſo conſiderably increaſed in bulk, by fermentation, that they become buoyant.

THE next article to be treated of, according to the method propoſed, is the aſperity or roughneſs of ſurfaces.

THIS property, which obtains more or leſs throughout univerſal nature, is a very conſiderable impediment to mechanics, eſpecially to wheel carriages and compound machines; and is generally known by the term *Friction:*

THE laws of which are, firſt, That it obtains in proportion to the weight of the impinging ſurface, and not in proportion to its quantity of ſurface.

SECONDLY,

SECONDLY, That the quicker any ſliding ſurfaces move, the more the friction is *(cæteris paribus.)*

THIRDLY, That the larger the promontories and cavities in ſliding ſurfaces, the more it obtains.

BY knowing the peculiar cauſe and properties of any impediment, we are ſooner directed to the remedy: Hence, as a narrow ſurface has no more friction under a given load than a broad one; and as poliſhing or reducing the promontories and cavities reduces friction, we ought to reduce the quantity of rubbing ſurfaces to the ſmalleſt ſize that can ſupport the work, becauſe a ſmall quantity of ſurface is eaſier poliſhed than a large one.

AND, As friction increaſes with an increaſe of motion, we are to uſe all convenient means to reduce the celerity of the parts that occaſion friction. For which purpoſe, friction wheels of various kinds and ſizes have been introduced; but as oil or greaſe, of a proper quality, is, in my opinion, and that opinion is founded on ſome experience, the beſt friction-wheels for wheel carriages, engines, and other large machines, I heartily recommend ſuch to the preference of all others.

AND further, as a ſmall pivot, or buſh, turned round by the ſame radius that turns a larger pivot or buſh, and in the ſame time, will move ſlower, and conſequently have leſs friction than the larger pivot, &c. it muſt be proper to make all pivots

as

as ſmall as the work they are to do will admit in all machines that act continually in the ſame plan.

And laſtly, As friction increaſes with an increaſe of weight, on account of the promontories being thereby ſunk deeper into the ſurface they are in contact with, it muſt be highly neceſſary to make the poliſh as perfect as poſſible, and the parts as hard as may be. And as ſimilar metals, on being highly poliſhed, and much compreſſed, are more liable to be affected by the attraction of coheſion, than metals of different textures, it may not be improper to make the buſh of one kind of metal, and the pivot of another; and for moſt common uſes, caſt iron buſhes and ſteel pivots do very well. With reſpect to the friction peculiar to the plough, cart, &c. ſhall give a more particular account of it when we come to the explanation of thoſe inſtruments.

So far as we have taken a view of friction, it ſeems to be an impediment to mechanics; however, like all other properties of nature, it has its uſes. One inſtance, of many that might be advanced, I ſhall give, viz. The vaſt importance it is of in building. For were the bed of a courſe of maſonry poliſhed, as cuſtom and elegance require the face of the work to be now-a-days, the work would not be near ſo ſtrong; becauſe the promontories and cavities in the bed of ſtone or brick inſiſt on one another, ſo that there can be no ſliding off; and a general contact is more effectually accompliſhed by the lime or bitumen, provided it is good, where there are ſmall cavities, than where there are none.

Having

HAVING mentioned that the mortar, or bitumen, ought to be good, ſhall, in as few words as poſſible, ſhew how to make it ſo, if the lime is not altogether improper for the uſe. Lime, while it remains in an unmixed ſtate, greatly attracts oleaginous particles, and thereby renders itſelf effete. (See note, page 95 and 96.)

HENCE the uſe of mixing it with ſand, when it is to be made into mortar or bitumen; and as either large knobs of lime or ſand would prevent ſuch intimate union as is neceſſary effectually to prevent the lime from attracting oleaginous particles from the atmoſphere, and thereby impair its bituminous quality, it is highly neceſſary to reject all ſuch knobs.

HENCE the uſe of riddling lime: And in order to prepare the lime for riddling, without making too much refuſe, it ought to be carefully ſlacked with water; and the fewer oleaginous or vegetable particles the water contains, the better: River water, ſiſpool water, and even rain water, are therefore none of them the beſt for this purpoſe; but, above all, avoid ſalt water.

AFTER lime has been ſufficiently ſlacked and turned, which operation ought to be performed immediately on its arrival from the kiln, (otherwiſe the ſhells, or calx viva, muſt be put into a cloſe dry place, and be well covered) let it lie a day or

two, taking care to cover it; then give it another watering, and turn it carefully. Let it now lie a day or two more, but ſtill carefully covered; by which time it will be reduced to a fine powder, and pretty cool: Let it then be put through a riddle of ⅜ of an inch holes, and after that through one with ½ of an inch holes; what halts between, ought to be pounded and watered again, and kept a day or two, and it will then paſs the laſt riddle or ſieve.

THE lime being thus prepared, the ſand ſhould alſo be put in preparation; and as earthy particles, for the reaſons above given, will moſt certainly ſpoil the lime, ſuch ought to be carefully ſeparated from the ſand; to do which, it muſt be waſhed in a ſtream of running water; it ſhould be then put through a riddle or ſieve of ¼ of an inch holes, and then intimately mixed with the lime, and ſuch a quantity of water added, as with ſevere working will make the whole into a ſofteſh paſte.*

LET it now lie three or four days at leaſt, and then work it without water, if poſſible, into a degree of ſoftneſs, that the trowel can fairly ſpread it. Mortar or bitumen, thus prepared, and the proceſs is neither tedious nor expenſive, pro-

* THE quantity of ſand depends upon the quantity of lime: Strong lime will take two and a half loads of ſand to one of itſelf; ſome weak lime not above half a load, &c.

provided the ſtone or brick to which it is to be put be dry and poreous, and the mortar drawn in thin layers, if the ſeaſon is good, will, in three or four months, become ſo hard, and have taken ſuch bond, that neither froſt nor any reaſonable force can penetrate it; and in a few years will become as tenacious as ſtone itſelf: Whereas mortar, made in the inconſiderate manner that ſome ordinary tradeſmen do it, never arrives at a ſtate either ſufficiently hard or tenacious; and yet, by their immoderate uſe of it, they make their work ſtand to a greater expence, than if the work were furniſhed with mortar thus properly prepared, and uſed with propriety.

End of the Second Section.

SECTION III.

DESCRIPTION OF INSTRUMENTS, &c.

Explanation of FIGURE I. PLATE I.

THIS figure is the perſpective of a drain plough, for cutting large drains, for carrying off top water from marſhy land into main drains, lakes, &c. The thought was firſt ſuggeſted by the Society inſtituted in London for the enouragement of arts, manufactures, and commerce; and they propoſed to give a premium of fifty guineas to the perſon who ſhould contrive the beſt inſtrument for that purpoſe; making the cut twenty inches wide at top, ten inches wide at bottom, and twelve inches deep, ſloping equally on each ſide; and the contents to be alſo thrown out on each ſide equally.

THESE particulars being premiſed, and the advertiſement coming to my hand, I conſtructed this inſtrument as it is re-

pre-

preſented in this plate; and am not certain that any improvement has yet been made, although ſundry people have varied the conſtruction, but are obliged to copy the principle for want of a better.

THE ſociety were ſo exceedingly cautious in deciding the claim, that they appointed a time for a full trial of each candidate's machine, made in full ſize: In conſequence of which, ſix or ſeven ploughs, of different conſtructions, were tried, but proved all inferior to the above; and ſo great was the committee's impartiality, that although I was to all the numerous company that attended the trial an entire ſtranger, they voted me the full premium.

THE parts of it are as follow, viz. A, the roller which ſerved to prevent the plough ſinking too deep, and at the ſame time, by a vertical knife fixed in the middle of it, cut the ſward two inches and a half deep exactly where the middle coulter was to come; which coulter compleated the cut. The other two coulters were fixed to the ſides of the ſhare or ſock, which was exactly the width of the bottom of the drain; and the upper ends of the outſide coulter were fixed in the outſide beams, and ſo extended at the ſurface of the cut, as to form the drain twenty inches wide at top, as required. The contents of the cut being thus divided by the three coulters and the vertical knife, and fairly cut at bottom by the ſhare E, they aſcended upon an inclined plane on each ſide, as C.

THESE planes were ſupported by the heels D, and extended as high as the ſurface of the ground; and as ſoon as the furrows attained that height, a mould board on each ſide, as B, turned them over in the order they lie upon the ſurface of view, No. 6, which repreſents, in due proportion, the cut or drain the plough made on the day of trial. No. 2, is a hind view of the plough. No. 3, a view of its front. No. 4, the plan of its three beams. And No. 5, a view of the back of its

ſock

ſock or ſhare. All which give ſo clear an idea of its conſtruction, that any further deſcription of it ſeems quite unneceſſary, either for making or occcupying it.

Explanation of FIGURE II. PLATE I.

THIS figure repreſents the furrow ſide of a ſingle mould broad drain plough, fit for making cuts or drains, ſuch as ſhewn at No. 5, ib. which drains are very proper to be made between ridges in graſs fields, to prevent the growth of ruſhes and other cumberſome aquatics, that are the conſtant attendants of a too great quantity of moiſture. Beſides the advantage of laying the land dry, the furrows that are thrown out by this inſtrument may be converted into dreſſing for arable land, or even for graſs land, although I think it more ſuitable for the former than the latter. And the moſt effectual way of preparing it for theſe uſes is, firſt, let a man follow the plough, and ſtrike the furrow into pieces of eighteen or twenty inches long with a ſpade or old ax; then let the pieces be carted into heaps in ſome convenient place; and after they have laid as long as to become mellow, ſhive them down, and turn them over, taking care to mix ſome lime, coal aſhes, or ſome other inſtrumental manure with them; after which ridge up the heaps, ſo as they may not be ſaturated with wet; and let them remain ſo until the land is ready to receive them. Twenty or thirty cart loads of this ſort of compoſt to an acre, will make great improvement on old land.

THE conſtruction of this plough being ſo ſimilar to that above deſcribed, little need be ſaid to make it clearly underſtood: However, leſt any reader ſhould be at a loſs, I ſhall explain the moſt eſſential parts. A is the regulating wheel, which, by the radius F, may be ſo adjuſted as to fit the plough for cuts of various depths. H, H, two coulters faſtened to the wings of the ſhare, and ſcrewed into the bar G; they are ſo extended as

as to make the intended width at top, and equally ſloping on each ſide: But for rough land, I think the ſhare, No. 3, anſwers better than the two coulters, when its two wings K, K, are ſo turned up as to form the cut or drain. Whatever way the cut is made, the contents are forced up the inclined plane C, which is ſupported by the heel D, as in the large plough; and the mould board B turns the furrow clear of the drain, as ſeen on the right of No 5, if it is graſs land; and as ſeen on the left of ſaid No. if tillage land. No. 2, is a hind view of this inſtrument; and No. 4, a view of the ſhare which is to be uſed when the two coulters are uſed; but that may not often be the caſe, as the ſock, No. 3, is certainly the better Method, provided the top, or head of the plough, be ſufficiently ſtrong; for which purpoſe, the iron ſtrap, which is lapped over the beam on each ſide of bar G, and clinched under the head at the point of the ſheath where the ſtreſs lies, is provided.

THERE have been a great many of thoſe ploughs made and uſed in the kingdom, and ſeveral ſent out of it: Nor is it to be thought ſtrange, if thouſands more are made, as any one of them will do as much work in one day as 200 men, and to better perfection; conſequently ſave their price in one day. The double mould broad plough requires eight horſes; and will coſt, when well made and fitted up, about ſix pounds: The ſingle mould broad plough, four horſes; and will coſt, when quite complete, about four guineas.

Explanation of FIGURE I. PLATE 2.

NO 1, and No. 2, in this plate repreſent a view of the land ſide of a plough equipt for trenching land. No. 2, is the firſt plough or part which pares the ſurface from one inch and a half deep, to two inches and a half deep; the ſin on the

the land ſide of the ſhare, as ſeen in the figure, ſerving for a coulter to ſcore out the paring on that ſide, and the ſhare being webbed, as fig. I., clears the bottom of it, and is thrown into the bottom of the trench made by the ſtrong plough, No. 1, which follows in the ſame direction, and throws its furrow upon it.

IT is to be obſerved, however, that there can be no trench for the paring to fall into the firſt bout, unleſs one is made with a ſingle plough before this inſtrument begins: But as this kind of work is generally practiſed on ridged land, the firſt bout may be made with the trenching plough, No. 1, by letting down by radius O, wheel R, from line U to line T, which will prevent the paring plough, No. 2, entering the foil. N is the cat-head, which, by means of a piece of wood, nine or ten inches long, tenon'd into the off ſide of the beam, with holes in it to receive the bolt, any quantity of land may be given to or taken from the plough; and by the notches in the inſide of the bar, the tow chain and wheel may and ought to ſuit each other; for it would be exceedingly wrong to load the wheel with the horſes pulling from the the higheſt notch, when the wheel would cleave to the ground, when they pulled from the loweſt notch, or even from any of the intermediate ones.

WHEN this inſtrument is to be uſed as a paring plough only, the part, No. 2, is to be taken off, and the pivot K ſtruck into the ſquare hole in the iron ſtrap at Q, with its end, on which a hand ſcrew appears in the figure; which hand ſcrew is to faſten the ſaid pivot, by compreſſing the coulter and ſtrap Q between the ſhoulder of the pivot and itſelf; which office the piece E performs when the pivot K is not wanted.

THE pivot being thus fixed, and projecting to the land ſide, wheel I is to be put upon it; and the tread of it ought to be as much above the bottom of the plough as the intended thick-

thickneſs of the turf that is to be cut, its uſe being to tread on the ſurface, and regulate the depth of the cuts. Hence, if turf of various thickneſs is to be cut, wheels of various heights will be required; and as any thing will do for a wheel, that can be no great inconvenience. Wheel R is alſo to be let down to the ſame line, and ſhare L nicely ſharpened, and made of good metal, is to be put upon the toe of the plough.

A PLOUGH, thus equipt, I know, by experiment, will make very good work, provided the ſward is level, and not incumbered with ſtones, buſhes, &c. If it is ſo incumbered, I hope the reader will take no umbrage at my telling him, without heſitation, that no inſtrument will anſwer the purpoſe ſo well as the paring ſpade. Fig. M is a coulter, which, when fixed to the ſtrap Q, by pivot K, or the piece E, fills up the open that now appears between the coulter and back of the ſhare: A thing very neceſſary to be done, when rank ſtubble is to be turned down with the plough; and alſo when fine mould is to be ploughed in. Fig. H is a plan of the mould board; *a*, *b*, *c*, ſhewing the angle of projection required to turn the furrow, until its center of gravity has ſufficient power to do it. The whole has been laid down from the annexed ſcale.

WITH reſpect to the uſes this plough is intended to anſwer, namely, the trenching and paring of land, there need be no doubt of both operations being highly ſerviceable to huſbandry, under the following reſtrictions.

THE reſtrictions relative to trench ploughing, are, Firſt, never perform the operation, without making the land a good ſummer fallow.

2. NEVER perform it at all, where the bottom you bring up is a ſheer ſand, ſlate, or mineral ſtratum.

3. FOR corn husbandry, never trench above ten inches deep: for although the roots of corn do extend themselves beyond that distance; yet it is better to give them space sideways than downwards; because the nourishment they then receive is food for the seed of the plant; whereas what they extract from so great a depth, not having had the influence of sun and air, is only food for the straw; and hence it is that very deep ploughers have always late harvests.

4. ALTHOUGH land, that has been rendered light and open, by burnbeating, or other means, will be improved by trench ploughing, suppose the next stratum is clay, yet let not above an inch and a half thick of the clay be taken up at one fallowing.

5. IN all cases forbear trenching in wet weather, and even when the land is wet; and, in every instance, except the last, let the crop be well rolled in the spring, taking dry fesh weather to do it in.

THE RESTRICTIONS necessary to be observed relative to burnbeating, or paring and burning of land, are, first, that no fine old sward, that has been often top-dressed with dung, be put under this course, as the fire would dissipate the finest particles of it. This, I suspect, will not be relished by husbandmen, who usually put such land under a course of burnbeating, in order to have a rich turnip or barley crop at breaking up: But if such people will please to make trial of the following mode of breaking up such land, they will, I am certain, have as good crops, and do their land much less hurt.

A BRIEF account of the course, viz. Some time in the winter, antecedent to sowing the turnip or barley crop, when the weather is fresh, although it be a little wet, take the trenching plough, and set the paring department to cut as thin as possible, and the trenching department to turn up three inches below

low that cut; and if it is ſcored by a middle coulter, ſo much the better. Let the field lie in this way until barley ſeed time, and then, after the ſeed is ſown, harrow it ſoundly; which, together with the froſt it has been expoſed to, will make it cover well. If the ſeaſon is dry, let the barley be ſteeped a few hours in ſalt water, which will greatly facilitate its growth, by attracting the moiſture of the air and ſoil; whereas ſteeping in fair water, really makes the grain longer of ſprouting in a dry ſeaſon.

If turnips are wanted, the field is to be treated in the ſame manner; but need not be broke up until the beginning of July, if the ſoil is really good, and eat bare: After it is broke up, as above directed, harrow it well, and ſow two buſhels of ſalt on each acre, which is a leſs expence than burnbeating; then give it the ſeed, and harrow it in lightly, and doubt not of having as good a crop as burnbeating would have produced. If it is a ſour iron ſtaple, and poor clay below that is to be broke up, by all means burn it. No other mode can enable the tenant to pay any rent for it; nor is it injurious to the proprietor. What I mean by an iron ſtaple, is ſuch a ſoil as impregnates water, that has lodged in it any time, with an acid taſte, and makes it of a red colour: Or, when a bit of the ſoil is burnt, as ſoon as cold, if an artificial, or real magnet, is thruſt into the aſhes, it will come out loaded, as if thruſt into ſteel filings. The fire occaſions the iron, which the ſoil contains, to ruſt; whence it becomes leſs detrimental, if not more ſerviceable to vegetation, than when it was in its original ſtate.

There is ſomething peculiar in the conſtruction of the above plough, it having no other ſhath or foot to receive the ſhare, than the point of the land handle or ſtilt. This conſtruction I recommend to ſuch only as cannot be ſerved with oak, or good aſh, of a proper caſt for ſhaths; for the conſtruction of No. 3, in the ſame plate, is leſs liable to vary, or be out of order; and alſo rather an eaſier expence at firſt.

PLOUGH, No. 3, is ſo ſimple in its conſtruction, and ſo well known, that a minute detail of its parts would be miſpending time. The cops, or buck G, is not ſo generally known nor uſed as it ought to be; but, by the figure, I think it is ſo eaſy to be underſtood, that little need be ſaid to make it well underſtood. The notches which appear at end G, are to receive the hook of the tow chain or ſoam the horſes or cattle are to pull from; and by ſhifting that hook more towards the unploughed land, you take land from the plough: By ſhifting it to the furrow ſide of the plough, you give it land; it ought therefore to be made about eight inches wide, to have the plough in command on all occaſions.

THE two circular heads at the other end of the inſtrument being made with holes, as ſeen in the figure, is calculated to give the plough a greater or leſſer hold in the ground, by means of theſe holes being occupied as the plough requires, by a bolt that paſſes through the beam and into theſe holes: The holes in the middle of the cheeks of the inſtrument having a bolt through them; and the beam ſerves as a fulcrum to occaſion the depreſſion and elevation of the notched end, and thereby ſupercedes the cat-head deſcribed above.

FIGURE A, is a plan of the bottom of the plough; and angle *a*, *b*, *c*, is the plan of the top of the plough at one foot high. The whole is laid down from the ſcale in the plate, and will be found to anſwer the following dimenſions, viz. the width of the ſhare at five inches and a half, the ſpace for ſheathing, or clouting included, that is, from dotted line to dotted line: The tail of the plough below, from dotted line to dotted line, is ten inches: And between the land ſide and the hind part of the mould board, (at twelve inches high) as *a b*, is one foot five inches and a half; and the length of the mould board, or line *a b*, two feet ſeven inches and a half.

THE

THE plough being thus conſtructed, and the mould board hewn, or caſt to the natural ſhape which thoſe dimenſions will conſtitute, the furrow will be thrown off with great eaſe and certainty; nor can it ſpring back again, as the hanch of the mould board wreſts it, until its center of gravity acts againſt its recovering a perpendicular ſituation. Fig. D, is a ſock or ſhare ſuitable for gravelly ſoils: Fig. C, a ſhare ſuitable for all clay and loamy ſoils; and B is a coulter, with a mortiſe in it, for the convenience of taking piece E to faſten the coulter, and ſtrap Q in the trenching plough together. F is the ſhape which the ſhank of a coulter ſhould be wrought to, in order to ſlip ſtubble and other litter that comes againſt it.

THERE is a plough uſed in almoſt every part of the kingdom, where there is ſandy or gravelly ſoil; which is yet ſimpler in its conſtruction than the plough, No. 3, having only a piece of twiſted deal for its mould board, and its other furniture equally plain and ſimple: But as plough, No. 3, anſwers for all ſoils, and this half made plough only for particular ones, I thought plough, No. 3, beſt deſerving of being exhibited to public view; nor do I know there ever was, or ever will be, a better conſtruction of a plough for general uſe than this is.*

A PLOUGH of this conſtruction, made in the beſt manner, and of good aſh wood, with an oak ſhath or foot, and both land and furrow ſides ſheathed with plate iron, or the mould ſide all of caſt iron, can be had for about 33 s. in many places for leſs money; and it will do as much work, and with as much eaſe, as a wheel plough at ſix or ſeven pounds, or any other kind of plough; and in ſtony, uneven ſoils, will make good work, when the wheel plough cannot act at all. I do not advance this aſſertion, with intention to injure any perſon that has invented wheel ploughs, and offered them to the public: Such men undoubtedly thought they were doing their fellow

* It was invented by Mr Lomax, who obtained a patent for the ſole vend of it; but both he and patent are extinct many years ago.

low ſubjects ſervice; and therefore their motive is a juſtification of the act. And as my experience of ploughing in different counties, and buſineſs as an author, oblige me to declare to the public what conſtruction of a plough to me appears the beſt, I hope ſuch men will allow my motive to be a fair one alſo.

Explanation of FIGURE I. PLATE 3.

FIGURE I. No. 1, in plate third, is a turn-wriſt plough, or plough for banky land. When land is ſo ſteep or banky, that the cattle cannot drag the plough in its work to the ſummit of it in a ſtraight line, without evident diſtreſs, ſome other mode of ploughing muſt be adopted, that is leſs injurious to the cattle, and yet as ſerviceable to the crops ſuch land is to be put under. To anſwer this purpoſe, various inſtruments have been tried, and none that I know of to better account, than the three following, viz. When a hill or knowl, as ſteep as has been deſcribed, is to be ploughed, if it is all the property of one perſon, the plough, No. 3, plate 2, will perform the work as well as any other; if the tow chain hook is ſo put in the cops as to prevent the plough taking too much land. This being done, enter at any part of the ſkirt or bottom of the hill, and go quite round the hill, until you reach the ſummit or top of it; by which means the furrow will be a ſpiral line, as it were coiled round the hill. This is an eaſy mode for the cattle, provided they can keep from ſliding; to aſſiſt which, the largeſt cattle are put in the furrow. It alſo prevents the waſhing off the ſoil by torrents of rain water that ſuch hilly land is ſubject to. And if a light ſcoring plough, with one horſe, is employed to ſcore or grove the back of each furrow before the ſeed is ſown, the land will have the beſt chance for producing a crop; becauſe the ſeeds may then be got properly covered with mould, which is difficult, if not impoſſible to do, when

when the furrows are laid flat at one another's ſides; and that inconvenience is unavoidable in ſuch ſituations.

WHEN the hill or knowl is not all the property of one perſon, nor wanted to be all held in tillage, the turn-wriſt plough is to be uſed; that is, a plough, the mould board of which will turn, ſo as to ſuffer the plough to make good work on its return, and ſtill lay the furrow down the hill. The way the plough, fig. 1, performs this operation, is by having two mould boards connected by hinges to a bolt, which is fixed to the plough head and the beam, as appears in the figure. When the plough works in the direction given it in the plate, the mould board on the near ſide is folded up againſt the beam, and held there by a ſpring catch, as alſo appears in the figure. When the plough returns, the mould board, that is now folded up, is let down, and locked to the hind bar at *o o*, by means of the two projecting ſtraps S S.

THESE ſtraps are of due length to form a proper width at the heel of the plough, between the head and mould board, and ſufficiently ſtrong to preſerve it. This mould board being let down, the other one is folded up againſt the beam on the other ſide, and held up by a ſpring catch, in the ſame manner as the other one. The locking and unlocking behind is performed by the ſhutting or drawing a bolt into or out of the holes in the ſtraps at S S, and ſtaples, as expreſſed in the hind view, No. 2.

IT is to be remembered, that when the plough returns, the tow chain hook muſt be ſo ſhifted, as to give the plough a proper quantity of land: For which purpoſe, the notched end of the cops, or buck K, ſhould be nine or ten inches wide, extending equally to each ſide. The coulter is to be ſet exactly over

over the point of the ſhare, and the ſhare made with a narrow wing on each ſide, as No. 4, fig. S.

THIS plough, when the land is free from rubbiſh on the ſurface, will make very good work; but if there is a rank ſtubble upon it, as the mould board that is folded up will be apt to detain it, and thereby throw the plough out of its work, I recommend, in ſuch caſes, or indeed in any caſe, the manner expreſſed in No. 3, for changing the mould boards. *b b* repreſents the hind ends of the two mould boards; the fore ends of which are connected to the bolt which paſſes through the plough head, and alſo up through the beam, by collars rivetted to the middle of the mould boards: A ſheet of broad plate iron, cut to the ſlope of the bolt, and welded together again, and properly extended behind, and twiſted outwards above, will anſwer the purpoſe exceeding well; and in order to keep them extended behind, a piece of bar iron, as *a a*, looſely rivetted to each mould board, and two holes in it, as repreſented at *a a*, will effectually equip and ſupport the mould boards in their alternate uſe, by a hole being made in the middle piece of the plough tail, *c a*.

THIS hole is to go quite through the piece of wood, and ſlope downwards as it goes, to prevent the bolt that faſtens the bar *a a*, by paſſing through either of the holes *a a* occaſionally; I ſay occaſionally; becauſe when the plough is going in the direction it has in the plate, hole *a c* is to be bolted to the piece; and when the plough returns, the other hole is to be bolted to the piece. This, and ſhifting the tow chain, is all the trouble that need be taken at turning, to make the plough bring as good a furrow back as forward; and provided that bolt has a handle to pull it out, and the collars that connect the bolt at the fore ends of the mould boards to the mould boards, allow the mould boards to change ſides with eaſe, the whole may be done in leſs than half a minute.

FIGURE

Deſcription of FIGURE II. PLATE 3.

SANGUISORBA (Burnet) This plant, according to Lin. Gen. Plant. 136. the characters are as follow: *The empalement of the flower is compoſed of two ſhort leaves, placed oppoſite, which fall away. The flower hath one plain petal, cut into four obtuſe ſegments, which join at their baſe. It has four ſtamina the length of the petal, terminated by ſmall roundiſh ſummits; and a four-cornered germin, ſituate between the empalement and petal, ſupporting a ſhort ſlender ſtile, crowned by an obtuſe ſtigma. The germin afterwards turns to a ſmall capſula, with two cells, filled with ſmall ſeeds.* There are four ſpecies of this plant; but the only one worth cultivation in this country, is the firſt, viz. that repreſented in plate III. figure 2.

Explanation of FIGURE III. PLATE 3.

NO. 3, repreſents a drill plough; the drawing is not in true perſpective, I own, having avoided that to ſhew more of its parts. I I a pair of ſhafts for a little horſe to go in; a large one is not wanted, as the work is light, and it would poach the land too much; L L a bar which ſtrengthens the hinges of the ſhafts; E, E, E, three mortiſes to receive the three coulters; A repreſents the ſhape of the coulter, the bulb at the end of which makes the grove or furrow for the ſeeds; B, B, B, in the ſame line of direction, are oval holes to receive the piece; N, No. 2, which conveys the ſeeds down to the groves made by the coulters; *a*, *a*, *a*, three ſhe's or damſels, like thoſe of a corn mill, to receive the ſeeds from the three hoppers R, R, R.

THESE hoppers are placed about eight or nine inches above the board, which contains the holes B, B, B, but parallel

thereto, and are ſupported by the frame, No. 4; which frame is ſupported by ſeven pillars, ſuch as *q*, No. 6. The hoppers and their ſhes being thus ſuſpended, and the ſhes pinned to a flat bar or ſword, as repreſented by the piece B, B, B, and held to their ſtation by an eaſy ſpring, they are jogged by the call or ſquare piece of wood fixed upon the ſpindle, which comes through the trundle O. The trundle O is turned by the cog wheel H, which is turned by the axletree Z Z, of the two wheels G G. The manner of placing the bridge *g*, for ſupporting the ſpindle and trundle, any ingenious workman will ſuggeſt; and alſo how the pillars are to be adapted to the mortiſes *t*, *t*, *t*, *t*, *t*, *t*, *t*, &c.

WHEN theſe parts are all properly connected, and the ſhes laid to an angle, or hang, that will ſuffer the ſeed to trickle out, when jogged by the call, a perſon is to take hold by the handles P P, and direct the whole, and the ſeeds will be covered in by the harles *d*, *d*, *d*. Theſe harles act upon the ſame principle with the ſcrapers that follow the ſtones of an oil mill; conſequently muſt turn upon a pin or hinge at the fore end, and be loaded at the hind end with lead, or any other heavy ſubſtance, as repreſented by the balls over *d*, *d*, *d*, to make the feet ſink in the ſoil.*

PROVIDED the land be in fine tilth, this inſtrument will drill very completely; and if the hoppers have each a kind of ſluice, to prevent the ſeed dropping out, when the inſtrument is turning at the end of the ridge, &c. there will be no loſs of ſeed; nor will it be bruiſed, as it is too apt to be by barrel inſtruments. This inſtrument may be made to ſhift its drills at pleaſure, or to drill always at one diſtance, as the proprietor chuſes.

THERE

* *f*, *f*, *f*, in No. 4, repreſents the plan of the ſhes; and O, the guide beam for the ſpindle of the trundle O.

THERE are inſtruments of various conſtructions for performing this neceſſary work; however, where the land is in good tilth, as before hinted, I never ſaw any exceed this we have deſcribed; which, altho' it may appear complex on paper, is really ſimple in large. Mr *Craik*'s invention for this purpoſe is really ingenious, and ſo are the inventions of divers other gentlemen; but none that I have yet ſeen exceeds that preſented to the SOCIETY of ARTS, by Mr Thomas Hope, near Mancheſter, in point of ſimplicity.

Explanation of a PLOUGH that may be worked with the leaſt Force poſſible, PLATE IV.

THE very appearance of this plough indicates it to be greatly different from thoſe of the common conſtruction; and actual trial has proved, that it may be worked with leſs force than any other plough ever was: However, unleſs the ground is an abſolute plane, free from ſtones and other obſtacles, the plough, No. 3, plate II. deſerves preference; becauſe the parts which are ſubjoined, in order to reduce the reſiſtance againſt the team, cannot act, if the ſurface is at all rugged. Thoſe parts are as follow, viz. a pair of wheels U W, to turn upon an axletree, fixed in the ſtrap X, and the beam of the plough a little behind that point of the coulter and ſhare which meet with the greateſt reſiſtance, at which point the friction would moſt obtain. Wheel U, is to be adjuſted to tread on the land; and wheel W, to tread in the furrow; conſequently, if the wheels are both alike high, and that is moſt proper, the axletree muſt be a crank at one end, and the elbow let down exactly the depth of the furrow.

THE uſe of theſe wheels is to convert the plough into a wheel carriage, which they effectually do, by the aſſiſtance of the wheel in the frame R S. This wheel treads on the land, and is raiſed or depreſſed by the radius Y P, and kept at the neceſſary pitch by bolts let through the beam at Z, and the holes in the radius which correſpond thereto. This plough ſuſpended on theſe three wheels, and its coulter and ſhare laid to the beſt angles for cutting and raiſing the furrow, and the mould board made to lay the furrow in its proper direction, and at the ſame time give the leaſt check to the motion of the plough. Theſe things being ſo adjuſted, the work is performed with the greateſt eaſe poſſible; and yet the abatement in point of reſiſtance, in truth, is ſcarce worth notice.

THE only motive the Society of Arts had for trying this experiment, (as I have been informed) was to know for certain, whether the whole amount of friction, on a well conſtructed plough, was or was not an inconvenience worth providing againſt; and the reſult, fairly taken, is, that it is not. Much more advantage is gained by laying the coulter, ſhare, and mould board properly, than abating the friction. The protractor, which circumſcribes the plate, ſhews the angle of all the parts of the plough: And, I humbly preſume, that when land is dry, (and then it is fitteſt for being ploughed) that the parts of a plough cannot be made more ſuitable, than they are laid in this figure, and No. 3, plate II. &c.

THE parts of this figure that are yet undeſcribed, are the tiller L, roller M, and levers N, &c. the uſe of all which was to direct the plough into a wider or narrower furrow. For as the body of the plough was ſuſpended on wheels, there was not a poſſibility of caſting the plough into or out of land in the uſual way: I therefore attempted the buſineſs upon another principle, and ſucceeded very well, viz. by that of a three-wheel'd cart; and as the axletree of the front wheel, turned in

in a long mortiſe, as Q Q, the levers N O, being commanded by the tiller or handle L, by means of the chains and roller M, the wheel was thrown to an angle at pleaſure, and ſo inclined the plough either to the right or left, as occaſion required. If this plough was calculated for general uſe, I ſhould have been more particular in the deſcription: But as its principal uſe (and indeed no mean one) was to determine whether friction was or was not an object worth providing againſt in ploughs; that matter it decided, to the ſatisfaction of all but thoſe who were too ſanguine on the part of friction.

I HAVE ſtill omitted ſome few particulars relative to friction: And as I cannot detain the reader with a full detail of what may be advanced, in order to prove that the friction on ploughs is not worth providing againſt in any other way, than by ſheathing them with hard iron, I ſhall only requeſt ſuch as think otherwiſe, to conſider that a plough is more ſimilar to a wedge than a vehicle or carriage; and wheels would be rather a detriment than an advantage to a wedge: Let them, therefore, accommodate a plough in a ſuitable manner to its work, and they will, I hope, reap advantage thereby; and alſo in a little time, get cured of the prejudice they have entertained in favour of ſuch an ideal ſuccedaneum to reduce friction in ploughs as friction wheels.

THE other figures in the plate, are K, the ſection of the inſide of a mould board, with the handle laid to it; the plan of the bottom of a plough which ſets to various widths behind, in order to ridge up a thin ſtaple; H, F, G, *q*, ſhews the form of the bottom; and *a b* the bolt and ſocket, which, by means of the hand ſcrew and hinge at H, is capable of regulating the width of the plough-tail at pleaſure. There are many other methods for effecting this purpoſe; but I know of none either more effectual or ſimple than this.

THE

THE next figure in this plate, is the profile of the cops or cat-head. D, the tow chain hook, and C, C, D the angle which the tow chain forms with any line drawn parallel to the baſe of the plough, when the horſe's ſhoulder lies ſimilar to the hypothenuſe of the angle A, C, B. The deſign of this figure is to ſhew, that the collar C, and the line C D, or tow chain, ſhould always form a right angle when horſes are harnaſſed for plough foot; and at leaſt from the ſtaple near C, to the belly ſtrap, when in a cart, waggon, &c.

THE reaſon of all this is obvious; for when the line of draught is perpendicular to the ſlope of the horſe's ſhoulder, the collar, or brigham, will act upon the whole ſhoulders, and conſequently injure them the leaſt: And if the line of draught is confined to that poſition by the belly ſtrap, all danger of choaking is precluded; and, moreover, ſuch a direction of the line of draught alſo combines the weight of the horſe, and his muſcular force; which, in every other mode of harnaſſing, will, in ſome degree, claſh with one another. The other nine figures in this plate yet remaining to be deſcribed, are common graſſes; ſeven of which, viz. the meadow fox-tail, creſted dog's tail, common poa, great poa, annual poa, ſheeps feſcue, and meadow feſcue, I have copied from drawings in the *Muſeum Ruſticum*; becauſe I could not have made better, notwithſtanding I had the real plants at hand. The ſame reaſon induced me to take the ſaint-foin from a work of the late Sir John Hill: But as I have not found any thing in books like to the other plant, viz. beſt Ray Graſs, I have taken it from Nature.

AFTER what has been ſaid reſpecting graſſes in the preceding parts of this work, a brief account of the above graſſes is all the reader will expect at this time: And, therefore, to be brief, yet faithful to experience, I am not authoriſed to recommend either the great or annual poa, meadow feſcue, or meadow fox-tail, as ſeeds to lay off land under; unleſs where the lands

lands are low and ſwampy, and then the meadow foxtail may not be improper, as I have before hinted. The creſted dog's tail, ſheeps feſcue, common poa, and ray graſs, may be ſafely recommended, there hardly being any certainer or better graſſes for paſture than they are, when uſed as I have heretofore directed. The other three, namely, the great and annual poas and meadow feſcue, are all of them great impoveriſhers of land, very coarſe herbage, and of ſhort duration; yet they make the principal part of country ſeedſmen's ſtocks, and ignorant farmer's crops on new lands: But it is bad conduct, and calls loudly for amendment, both on their part and the landlords. Theſe graſſes bear different names in different places; one calls them duffel ſeeds, another downy ſeeds, and a third white ſeeds; however, ſure I am, they ought all to deteſt them as pernicious ſeeds; and if it had not been to make them ſo well known, that they may hereafter be rejected with certainty, I ſhould not have troubled the reader with either a view or detail of them.

An Account of the PRINCIPLES of WHEEL-CARRIAGES.

THE early uſe of wheel-carriages ſuggeſts, that Mechanics is nearly coeval with creation itſelf; and the common uſe of thoſe machines, evinces the vaſt uſefulneſs thereof to mankind. Hence, the principles on which their beſt conſtruction depend, ought to be well known to thoſe who uſe them, if not to all.

To facilitate this laudable deſign, the Society of Arts in London propoſed, ſome years ago, to give a premium to the perſon who ſhould deliver to their ſecretary, the beſt account of the prin-

principles of wheel-carriages; and at the ſame time, demonſtrate their comparative excellence. The Society, ſtill further to illuſtrate this neceſſary point in mechanics, were at a very conſiderable expence in equipping an apparatus, to prove the principles given in by the candidates; and mine, which I now lay before the reader, were ſo far confirmed and approved of by them, that I received their approbation, and a reward of fifteen guineas.

THE principles I laid before the ſociety, were as follow, viz. 1ſt, That any direction of the line of traction, or line the horſes, &c. pull by, except line L L, fig. 16, plate V. was a falſe direction: Becauſe if they pull in direction *q* S, the wheel is drawn into the plane it moves on; and conſequently the moving power is thereby impaired.

2dly, THAT if they pulled in direction M S, part of their force was applied to lift the whole carriage upwards, inſtead of dragging it forward; and conſequently occaſioned a waſte of power.

3dly, THAT if the wheels were ſo high as to occaſion the line of traction to lie as *t* K; that then, altho' it was parallel to the true line of traction L L, whenever the wheel came to ſtrike an obſtacle, as X, the ſhafts acted with a purchaſe equal to the parallel diſtance of theſe lines againſt the moving power.

4thly, THAT if the wheels were ſo low as to occaſion the line of traction to be directed, as line *r* G; that then the ſame inconvenience obtained: All of which is not only agreeable to mathematical demonſtration, but ſelf-evident from the figure.

THESE inconveniences being conſtant attendants of an exceſs, either on one ſide or the other, it will be neceſſary to ſhew how this true line of traction, L L, is to be applied or adopted

adopted for general uſe; and, to be brief, it is in every caſe to be regulated by the ſize of the horſes or cattle, as follows, viz. Meaſure in a perpendicular line the diſtance from the top of the hoof of the horſe's fore foot, as *u*, to the center of gravity of his ſhoulder *u**, and make that diſtance the radius of your wheel, S *y*. In horſes of the middle ſize, that diſtance or line will be about three feet. Wheels that ſuit that ſize beſt, ought therefore to be ſix feet diameter. It may perhaps be aſked, why I meaſure from the top, and not from the bottom of the horſe's hoof; the reaſon of which is, that horſes feet generally ſink deeper than the wheels; and beſides, when a fair pulling horſe is in his labour, he does not meaſure ſo much in height as when he ſtands.

Now, as the line of traction ought to paſs through the center of gravity of the labouring cattle, and lie parallel to the baſe or common tract M M, the ſhoulders of the cattle will make an angle therewith, probably ſuch a one as A B. Hence, to give them the beſt chance to ſave their ſhoulders, and alſo to apply their whole weight and muſcular force to the beſt purpoſe, the hook of the chain or trace ought to be placed at C, and a belly ſtrap, as *a a*; and alſo a back-band, as *p n*, tightened ſo as to keep the chains or traces in the true direction L L. The traces being held down in that manner by the belly ſtrap, part C D will make an angle with A B of 90 degrees, or lie at right angles to the ſhoulder of the horſe, &c. as it ought to do. The chains of the ſhaft horſe ought to lie in the ſame order.

As a ſix feet wheel is conſiderably above the common ſize, and conſequently will ſtand to more money, I doubt not but my

* THE center of gravity for the purpoſe, may be near enough aſcertained, by fixing it where there ſeems to be as much weight of ſhoulder, cheſt, and quarter above it as below it; conſequently, it will lie higher in a thin-ſhouldered horſe than a thick-ſhouldered one, &c.

general criterion for the ſize of wheels may meet with oppoſition: But that cannot alter the fact; for it will ſtand any, the moſt ſevere examination. However, I muſt allow, that where the criterion is not adopted, that the leſſer wheel is preferable to the larger, unleſs you run into an extreme of ſmallneſs.

HAVING ſhewn what is the beſt ſize of carriage wheels, ſhall next explain the beſt method of laying out axletrees, and whether wood or iron is the beſt for general uſe.

FIRST then, as it is proved by experience, as well as theory, that wheels move with moſt eaſe when they are placed parallel to the line of traction; the arms of the axletree ſhould therefore neither incline forward nor backward; and as a long axletree is attended with much inconvenience to the moving power, it ſhould not be longer than is neceſſary to prevent overturning.* The wheels of a carriage alſo turn with the greateſt eaſe, *cæteris paribus*, when they are placed perpendicular, *i. e.* ſo as they be exactly the ſame diſtance, a part at top as at bottom: But as the diſh or bevil of the ſpokes of the wheel, ſpring of the axletree, &c. will conſtantly incline the wheels to ſpread at bottom, eſpecially when loaded, care muſt be taken to incline the arms of the axletree to the road; juſt as much as will occaſion the wheels to preſerve an upright poſition on a plane, when fully loaden.

THIS precaution is often carried to an extreme, and the wheel *e* made to overhang at top, in a degree that not only deſtroys unneceſſarily the moving power, but deſtroys both wheels and axletrees; and alſo makes the carriage more liable to overturn, than it is when the wheels are placed erect. I have aſſerted, that the ſmaller the pivot, or end of the arm of an

* THE arm of an axletree becomes a lever, when it extends beyond the place of connection of the line of traction, and has a bias to pull the horſes, &c. aſide when a wheel ſtrikes an obſtacle. Hence, as this bias increaſes with the length of the axletree, ſtraitneſs of the ſhafts, and ſhortneſs thereof, double ſhafts, made pretty long, a ſplinter bar, and wheel irons will abate the inconvenience.

an axletree, the leſs the friction, *cæteris paribus*, becauſe the motion of the buſh will be ſlower; which aſſertion is, in general, undoubtedly ſtrictly true.

HENCE, iron axletrees muſt be better than wood ones, unleſs in particular caſes, viz. When the roads are jumpy and deep; then are wood axletrees better than iron ones; becauſe when a wheel ſinks into wave or rut, as 7, fig. 17, plate V. the line of traction O R is changed into the line I R.

HENCE, if circle 1 be the buſh of an iron arm, and circle 2 the buſh of a wood arm, the face of the iron axle will impinge upon its buſh at point *a*, and the face of the wood axletree impinge on its buſh at part *b*; their purchaſe to overcome the reſiſtance of the wave, will therefore be as their quantity of elevation from line E Q, or as diſtance *a* 7, to diſtance *b* 7, reſpectively. The advantage gained by the wood axletree in this inſtance, is however counteracted in ſome meaſure by the weight of the wheels; for the iron axle has ſegment 3, 3, 5 of the wheel acting in its favour, when the wood axletree has only ſegment 4, 4, 5 that can act in its favour: But unleſs the wheel is very tall and heavy, the length of the lever gained by the elevation of the point of contact between the face of the axletree and buſh, will greatly exceed it; wood axletrees, therefore, are more ſuitable for deep country roads, than iron axletrees.

BESIDES the inſtances that have been given, with reſpect to the propriety of making the wheels of carriages twice the height of the center of gravity, taken horizontally of the creatures that draw the carriage, a further advantage appears very conſpicuous in the ſtriding over narrow waves, or from obſtacle to obſtacle, as in wave W. fig. 16, where wheel 20 dips into the very bottom of the wave, and wheel 30 ſcarce dips into it at all; altho' the wheel 20 is three feet diameter, and wheel 30 only ſix feet diameter. This ſort of impediment be-

ing very common, and its prevailing ſo much againſt the former, while it hardly affects the latter, ſeems to bear hard againſt the argument for rolling waggons, unleſs ſuch carriages are always to travel on even roads.

BUT there is yet a circumſtance that ſtill bears harder againſt them than it, for when theſe waggons, or even carts mounted upon rollers, travel over miry roads, &c. the preſſure of the atmoſphere, which, when they are heavy loaded, as they are always authoriſed to be, the quick motion of the rollers, even when the cattle go in a walk, their great width, and ſhort diameter, muſt greatly embarraſs the moving power, by generating a vacuum.

LET us take a view how much it may be reaſonably ſuppoſed to be, when the mire is only four inches deep: The rollers being two feet diameter, and fifteen inches long, there will be at leaſt 250 ſquare inches of each roller immerſed; the four rollers will therefore amount to 1000 ſquare inches, which, at five pounds on every inch, and I fear it is often more, the cattle have a reſiſtance of upwards of two tons to combat, and only a lever of one foot radius to avail themſelves of; the road alſo ſuſtains that additional load.

HAD the ingenious inventor of thoſe carriages paid a little attention to this circumſtance, when he exhibited before the Society of Arts, he would not, I think, have arraigned that reſpectable body of men in ſuch ſevere terms for with-holding the premium.

BESIDES the above objections which I have made to the rolling waggons, I cannot refrain remarking, that they probably are, or will be, if practiſed, a conſiderable detriment to bridges, in as much as they are allowed to carry ſuch enormous loads; and every one that has knowledge in mechanics muſt

muſt allow, that bodies ſtrike in the ratio of the weight and its velocity reciprocally.

HENCE, as the rollers move quicker than larger wheels, impinge on leſs ſpace, when on a pavement, and the weight they are charged with is greater than other wheels are charged with, the concuſſion they occaſion will be greater: Indeed ſo great, I am apprehenſive, as to break the bond of the mortar of bridges; the inconvenience of which is too obvious to need any explanation. Theſe things I mention only as probabilities, and for the ſake of public weal; and without deſire to offend or injure any perſon whatever.

FROM the ſame principle, I preſume to offer to public conſideration the following particulars, relative to keeping public roads in good order.

1ſt, LET an act be made, to commence in two or three years after notice is given, that all wheel carriages be of one width, from the inſide of the tread of their wheels.

2dly, THAT no waggon be allowed more than four horſes; and that the wheels of ſuch carriage be ſeven inches broad; and the fore wheels at leaſt five feet diameter, and the hind ones ſix feet diameter. This will give the wheels as much bearance on the road, as if they were nine inches wide on the tread, and of the uſual height; and at the ſame time, be much lighter, cheaper, and eaſier drawn, as it is the beſt height for the generality of horſes that can be propoſed.

3dly, THAT no cart be allowed more than three horſes; and that the wheels of a three horſe cart be ſix inches wide on the tread, and five feet and one half at leaſt high.

4thly, THAT every two horſe cart have wheels ſix inches broad on the tread, and five feet and a half at leaſt high.

5thly,

5thly, THAT the wheels of all ſingle, or one horſe carts, be three inches wide on the tread, and not leſs than five feet high; or four inches wide on the tread, and four feet high.

6thly, THAT all carriage wheels ſhall be ſquare on the tread. Theſe particulars, when duly conſidered, cannot be objected to, but by thoſe who are intereſted in keeping large waggons, I humbly preſume; and as the public bridges and roads are of ſuch ſerious moment to the public, eſpecially to the landed intereſt, I hope they will promote this method, or an improvement of it.

Explanation of FIGURE 18. PLATE V.

FIGURE 18, is a mill, ſo conſtructed as to ſeparate corn from the ſtraw in a manner much leſs diſtreſſing to mankind, and at the ſame time with greater expedition, than is done by threſhing, and conſiſts of the following parts, viz. A the ſails and axletree, B the cog wheel, C the trundle, D the ſpindle, E the under mill-ſtone, F the upper ditto, and G the hopper, with its appendages. Theſe are the principal parts of a machine; which, from trial, even in model, I am convinced will do the buſineſs effectually by wind; and if any perſon can conveniently have water to work a machine for this purpoſe, fig. 19 repreſents a ſection of ſuch a mill, whoſe parts are ſo few and ſimple, that particular references ſeem quite unneceſſary; ſhall therefore content myſelf with pointing out the method of preparing the corn for the machine, whether it be moved by wind, water, horſes, or men.

FIRST, open the ſheaf, whether it be wheat, barley, or rye, and take as much of it as can be held faſt with both hands; and while you hold it by the top, daſh the ſtraw, or bottom of the

the handful into the comb, fig. 20; which comb is to be made nearly in the ſame manner as a wool comb; only the ſpikes, or prongs of the comb, are to be ſo cloſe ſet, as to ſtop the head, and let the ſtraw ſlip. When all the looſe heads are combed out, change your grip from the top to the ſtraw or bottom of the handful, and daſh it into the comb again, and draw the ſtraw until the heads are even; or take a light thacker, as *t*, and beat the heads even; then take out the handful, and caſt it into the ſhears, fig. 21, which may be worked by a crank in the end of the axletree, as *a*; the ſhears being ſharp, and the blades kept parallel with piece *g*, the heads will be inſtantaneouſly cut off, and fall to the farther ſide; the ſtraw you may throw to the other ſide, either for reed or fodder. The heads may be then thrown into the hopper at random, as the ratch wheel *e*, which is to be turned by a laſh band, and harle *d* will draw them out regularly, and throw them into the eye of the upper mill-ſtone at *q q*. The upper mill-ſtone in machines for this purpoſe are to be fixed, and the under ones are to move; which effectually prevents the corn receiving any injury from the ſtones, by the ſpring of the bridge that ſupports the ſpindle; which ſpring, although it is exceedingly uſeful in making flour, would be detrimental in rubbing the corn from the huſk. The ſtones are to be laid together, or ſeparated by the ſame ſort of machinery that corn mills are; and the method of fixing the upper ſtone in the ſill, and the under one to the ſpindle, any mill-wright will readily ſuggeſt.

It is alſo to be obſerved, that the top or face of the under mill-ſtone ſhould be convex, and the bottom or face of the upper one concave, as the ſpaces *o o* indicate; and that the center of the eye, by which the heads enter the face of the ſtones, be made one foot, at leaſt, diſtant from the center of the ſtone. The upper ſtone ſhould alſo be made with a ſwallow on the foreſide of the eye; and the rows of the upper ſtone ſhould face the rows of the under ſtone. This, to farmers, may

be

be ſomewhat unintelligible; but to mill-wrights, no way difficult to underſtand, I dare ſay. Long ſtones are better for this buſineſs than ſhort ones, but need not be heavy. I ſee no difficulty of ſubſtituting caſt iron for ſtone in this caſe; but that I leave to the mill-wright: However, whether they be caſt iron or ſtone, let them be at leaſt five feet diameter; and the runner made to revolve at the rate of 15 or 16 feet per ſecond at leaſt; for it is by the centrifugal force, that the heads are chiefly thrown out.

THESE particulars being duly regarded, and the ſtones caſed round, except one quarter, the empty heads and ſtraw too, if it is thought convenient to cut it into pieces of ſix, ſeven, or even eight inches long, will be regularly diſcharged along with the corn, at a very ſmall expence of force; and if a grate or ſkreen Q *c*, be annexed, the corn will be ſeparated from the ſtraw without difficulty: And a winnowing machine may alſo be turned by the mill; by which the corn may be made ready for market the next moment to its being ſeparated from the ſtraw. I have not yet tried the machine with oats; but make no doubt of its alſo effectually ſeparating them from their ſtraw, if they are dry.

THUS have I deſcribed, in as few words as I could, a contrivance, which, I hope, will relieve the labourer, and yield both landlord and tenant conſiderable profit.

End of the Third Section.

A

VOCABULARY, or DICTIONARY

OF

WORDS,

Made Uſe of in this Work,

Which, to common Readers, may be unknown, as they are not to be met with but in Books of SCIENCE, &c.

A

AGRICOLA, a Roman General, who was a great admirer and proficient in huſbandry.

Aggregate, the ſum of ſeveral things added together, &c.

Analogy, the conformity or reſemblance between animals of different ſpecies, between plants and animals, &c. &c.

Analyſis, in a general ſenſe, is the reſolution of any art, or any thing compounded, to its conſtituent parts or elements.

Appellants, oppoſers, arguers on the contrary ſide of a queſtion, &c.

Approximate, to approach or come near the truth, or any thing ſought.

A priori, a ſpecies of demonſtration which deduces the effect from the cauſe; and is oppoſed to

A poſteriori, which deduces the cauſe from the effect.

Arborator, a perſon employed in dreſſing trees, having the care of woods, &c.

Aſtronomus, an aſtronomer.

Atmoſphere, that vaſt body of air and other matter which ſurrounds the earth, and is the occaſion of clouds, rain, ſnow, thunder, meteors, &c.

B

Baſis, or *Baſe*, the foundation of any matter or thing.

Bitumen, the mortar uſed at the building of the tower of Babylon.

C

Cæteris paribus, every thing equal or alike.

Caput mortuum, a dead head, or thing that is ſtript of its vivifying quality.

Ceres, the deity which the heathens worſhipped as the goddeſs of Agriculture.

Chyle, the firſt ſtate of the fluid ſecreted from the food, by means of digeſtion, &c.

Coloſſus, a thing of great bulk.

Compendium, a ſhort account or abridgement.

Contact, the act of touching.

Cotyledones, certain glandular bodies belonging to the exterior membrane which inveſts the fœtus of ſome animals.

Criterion, a ſtandard, by which the goodneſs or badneſs, the weight or levity, &c. of any thing is diſtinguiſhed.

D

Data, a term ſignifying the principles or quantities of things or numbers, in order to find other things or numbers that are wanted: Thus, if it was required to find a number which had the ſame relation to 10 which 2 has to 8, the data muſt be, if 2 give 8, what will 10 give, &c. &c.

Dele, blot out, or withdraw.

Diaphragm, in anatomy, a muſcular membrane which divides the thorax or breaſt from the abdomen or belly, and is a principal member in reſpiration or drawing in the breath, &c. &c.

E

Effete, worn out, barren, &c.

Embrio, the ſtate of any thing not finiſhed.

Empiricus, a perſon that has gained the art of phyſic by practice only.

Epocha, the time from which any thing began to be or reign.

Eradicate, to pull up by the roots.

Exotic, ſomething foreign, as a plant, &c.

Exordium, an introduction or preface, &c.

F

Farina-fœcundans, the impregnating meal or duſt of male plants, which being received by the ſeed veſſels of the female, fecundates the rudiments of the ſeeds in the ovary.

Fœtus, the fruit of the womb, after it is completely formed; before that, it is more properly called *embrio*.

Fortuitous, accidental, or unaccounted for, &c.

Fuliginous, whatever proceeds from a body by way of a thick, ſooty ſmoak.

Funiculus Umbilicalis, the veſſel through which a fœtus receives its nouriſhment in the womb.

G

Germ, the bud of a plant, &c.

Glottis, the windpipe of any creature.

Gravity, the natural tendency of bodies which are near the ſurface of the earth towards it.

H

Heterogeneous, in general, implies ſomething that conſiſts of parts of diſſimilar kinds, in oppoſition to

Homogeneous, an appellation given to things, the parts of which are ſimilar, or of the ſame nature, &c.

I

Impel, to drive forward, &c.

Impetus, the force with which one body ſtrikes againſt another.

Inſipientia, folly, or an author of folly.

Involucrum, a cap or covering for flowers, &c.

L

Lobes, a fleſhy protuberant part.

Lues-Venerea, venereal diſeaſe, or French pox.

M

Materia Medica, comprehends all the ſubſtances either uſed in medicine in their natural ſtate, or which are fitted thereto by preparations.

Maximum, the whole, or moſt perfect amount or effect.

Mechanician, an ingenious perſon that underſtands the laws of mechanics and conſtruction of machines.

Menſtruum, diſſolvents of any kind.

Minutiæ, ſmall, inconſiderable.

Nidus,

N

Nidus, a neſt, or proper repoſitory for ſeeds to germinate, or eggs to hatch in.

Noſtrums, medicines that have not been put to public teſt, and therefore ought to be ſuſpected.

O

Organization, the conſtruction or arrangement of the parts of bodies.

Ovary, a ſmooth, white ſubſtance, affixed to the wombs of females, and ſuppoſed to contain the rudiments of the fœtus.

P

Perfidia, perfidy and breach of faith.

Philoſophus, a philoſopher or lover of learning.

Plantule, the young plant which the ſeed contains.

Profit and Loſs, a term uſed by accountants when they enter their employer in their books.

Praxis, an example or practice.

Punctum Saliens, the firſt rudiments of motion in a fœtus, &c.

Q

Quieſcent, at reſt.

R

Ratiocination, the act of deducing conſequences from premiſes, &c.

Receptacle, a place or veſſel wherein any thing is kept.

Reciprocal, mutually or alternately between things, &c.

Ruſtico, a clowniſh, obſtinate perſon.

S

Scientific, according to ſcience.

Segment, any part of a circle leſs than the half of the circle.

Septa, a bed or layer of ſtone, &c.

Series, a continued ſucceſſion of things.

Serva, a woman ſervant.

Servus, a man ſervant.

Soror, a ſiſter.

Stamina, with botaniſts, are the male organs of generation in flowers: *Stamina* is alſo underſtood as ſignifying the original ſtock or principle which imprints the family likeneſs and conſtitution of a creature; and ſo I have uſed the epithet in many places of this book.

Succedaneum, that which can be put to ſerve for ſomething elſe.

Syſtem, a ſcheme, &c. which reduces many things to regular dependence.

T

Tenax, ſelf-willed.

U

Urbanity, civility, politeneſs, &c.

Umbilicus, the navel ſtring.

V

Vacuum, a ſpace void of every thing.

Velocity, ſwiftneſs, &c.

Vermicular, any thing that bears a relation or reſemblance to worms.

Viator, a traveller.

Vice Verſa, implies, that a thing is ſo far good, and on the contrary, bad; or, that we grow until we arrive at maturity, and then fall off, &c.

Viſcera, the entrails of the body.

FINIS.

DIRECTIONS to the BINDER.

The PLATES are to be placed at the End of the Book, as they are numbered.

Errata & Omiſſa.

Page 3, line 3, dele *s* in *Perfidias*.—p. 16, l. 25, for *dared*, read *durſt*.—p. 38, l. 12, for *ſeventeeth*, r. *ſeventeenth*.—p. 75, l. 18, for *ſealy*, r. *ſcaly*.—p. 84, l. 10, for *receptable*, r. *receptacle*.—p. 109, l. 17 and 18, for *ſtrait*, r. *ſtraight*.—p. 117, l. 26, for *property*, r. *excellence*.—p. 137, 2d note, l. 2, for *and therefore is*, r. *and therefore the moiſture is*, &c.—p. 190, l. 8, for *broad*, r. *board*.—p. 192, l. 25, for *ſtacked*, r. *ſlacked*.—p. 206, l. 25, dele the comma after iron.—p. 224, l. 10, for *inſtrument*, r. *plant*.—p. 240, l. 6, for *of*, r. *or*.—p. 280, l. 25, for *of*, r. *or*.—p. 283, l. 18, for *put on at right angles*, r. *put oppoſite*.—p. 284, l. 1, for *than at right angles*, r. *than in an oppoſite direction*.—p. 294, l. 3, dele *and well purified*.—p. 295, l. 19, for *ſever from*, r. *ſever ſuch free ſides from*.—p. 295, l. 17, for *as to*, r. *and to*.—p. 325, l. 19, for *bodies have*, r. *bodies that have*.—p. 327, l. 3, (and in ſome ſubſequent lines) for *promontories*, r. *prominences*.—p. 328, l. 2, for *plan*, r. *plane*.—p. 330, in the note, l. 1, for *quantity*, r. *quality*.—p. 333, l. 20, for *coulter*, r. *coulters*.—p. 340, l. 26, for *the ſhare at*, r. *the hoof of the ſhare*: And for *a b* (line 30) r. *r b*.—p. 341, l. 5, for *acts againſt*, r. *prevents*.—p. 344, l. 22, for *prevent*, r. *receive*.—p. 286, l. 22, for *p a*, r. *r a*.—p. 322, l. 12, for *fig.* r. *No.*—p. 352, l. 15, for *M S*, r. *m* S.—p. 353, l. 6, for *S y*, r. *S Y*.—p. 354, l. 25, dele *e* after *wheel*.—p. 359, l. 15, for *harle*, r. *berle*.

N.o 6.

N.o 3.

N.o 2.

N.o 4.

Fig. 1. Double mould Board
DRAIN PLOUGH.

A Scale of Feet.

6 5 4 3 2

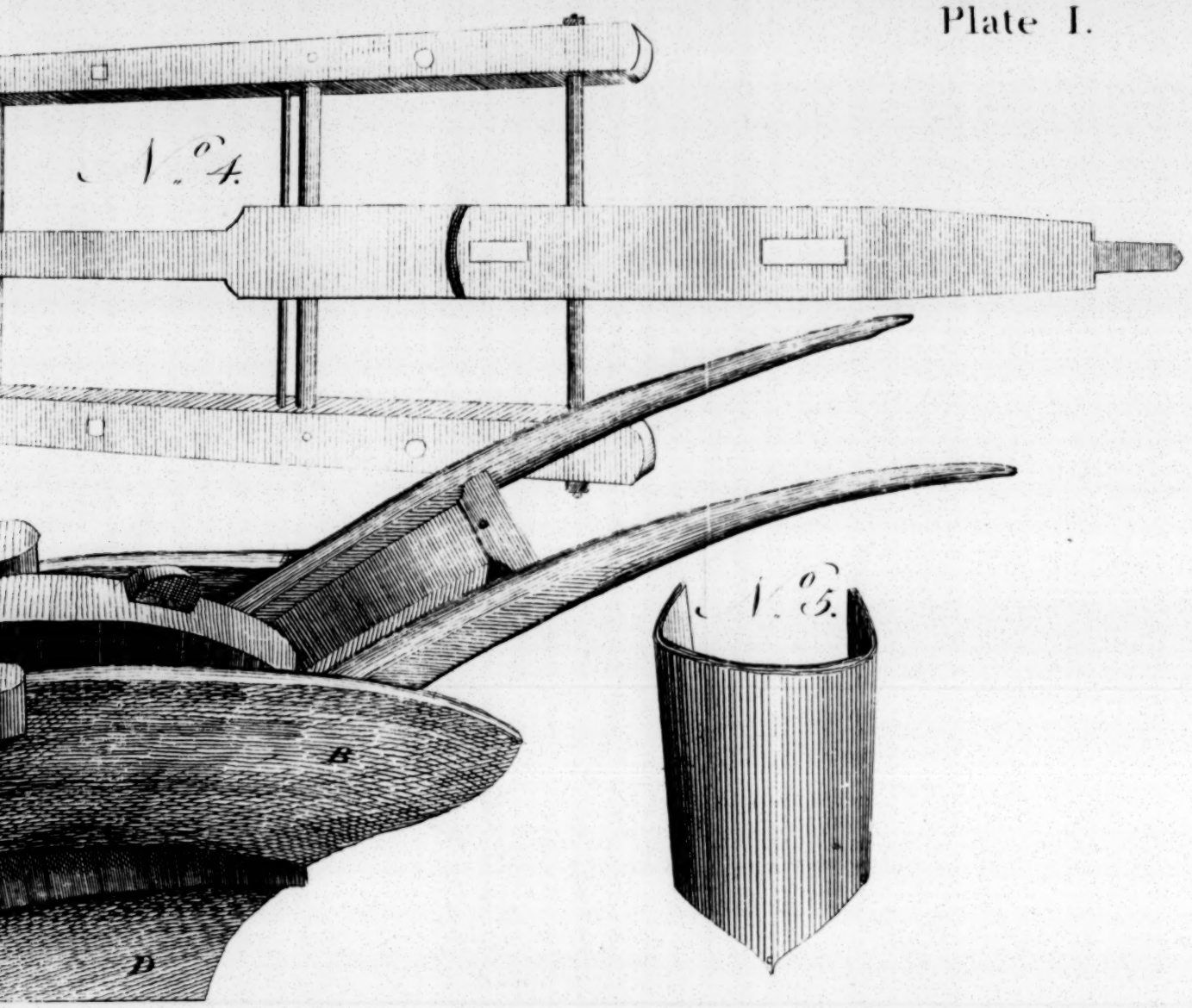
N.o 5.

Fig. 2.
Single mould
DRAIN PLO

N.o 2.

N.o 1.

Plate I.



Feet.



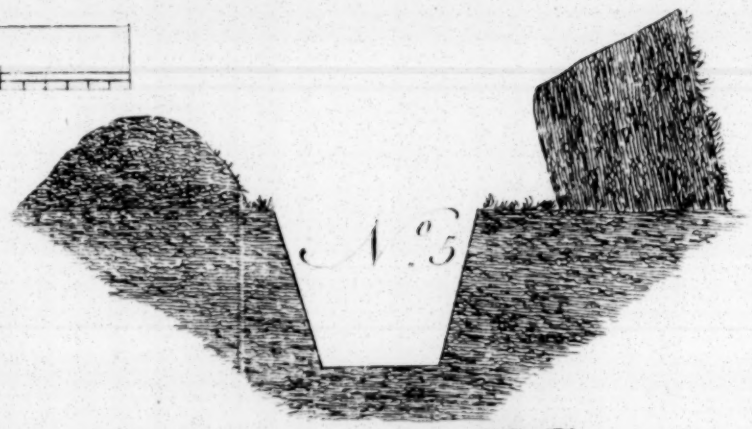
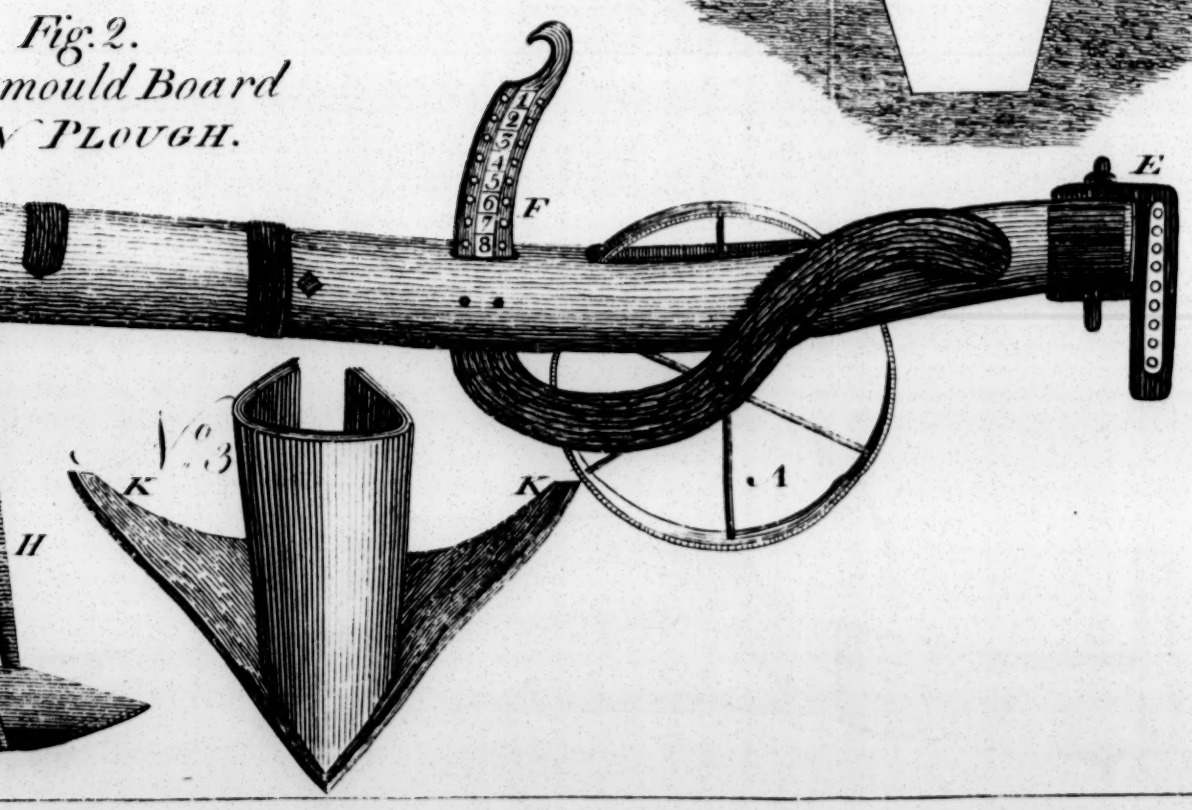
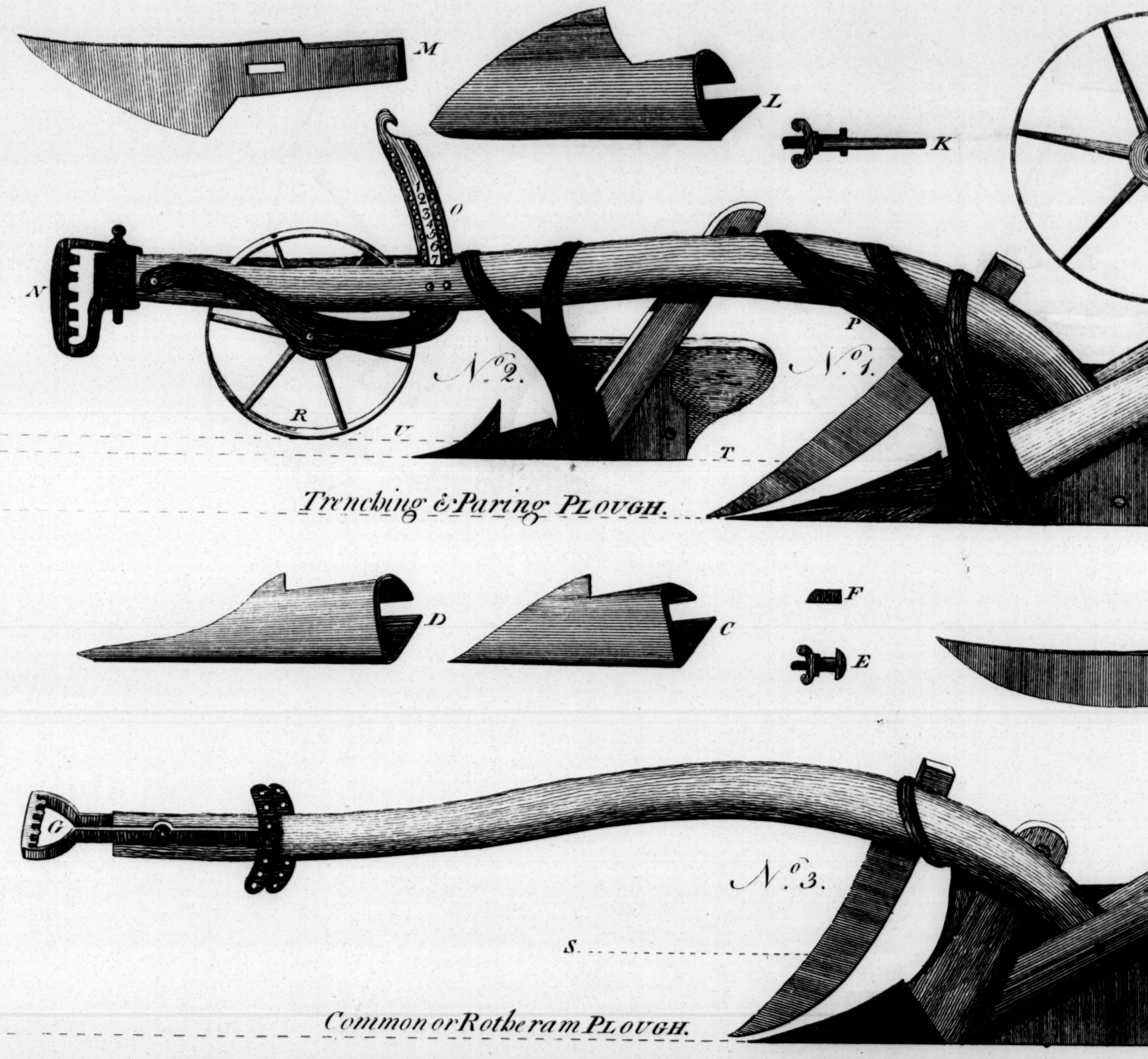


Fig. 2.
mould Board
Plough.





Trenching & Paring PLOUGH.

Common or Rotheram PLOUGH.

Scale of Feet

11 10 9 8 7 6 5 4

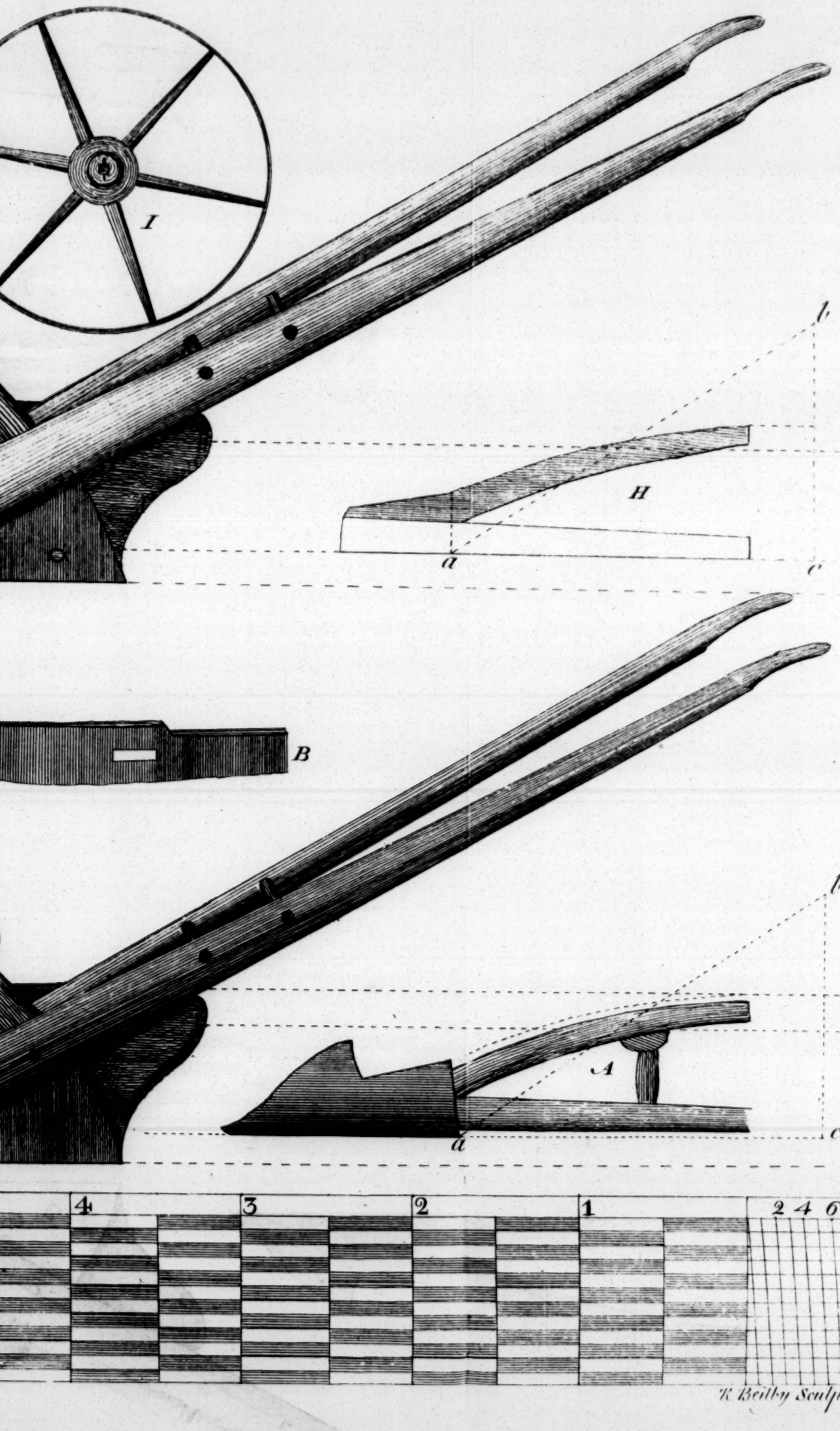
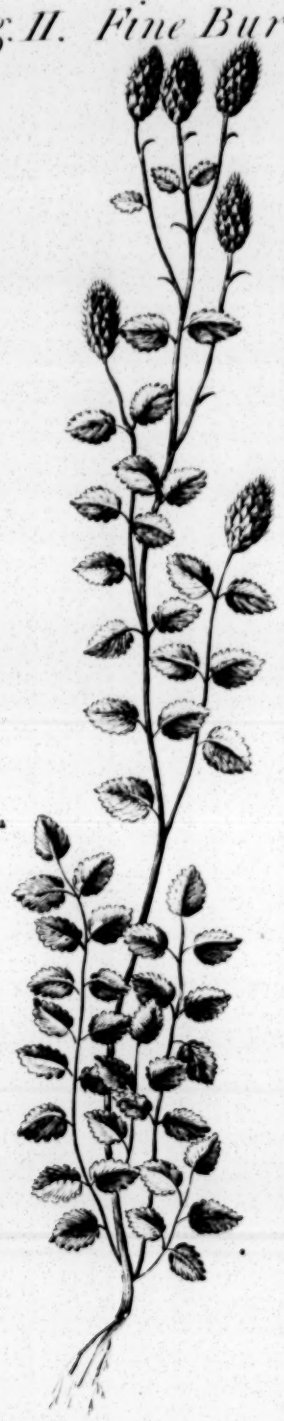
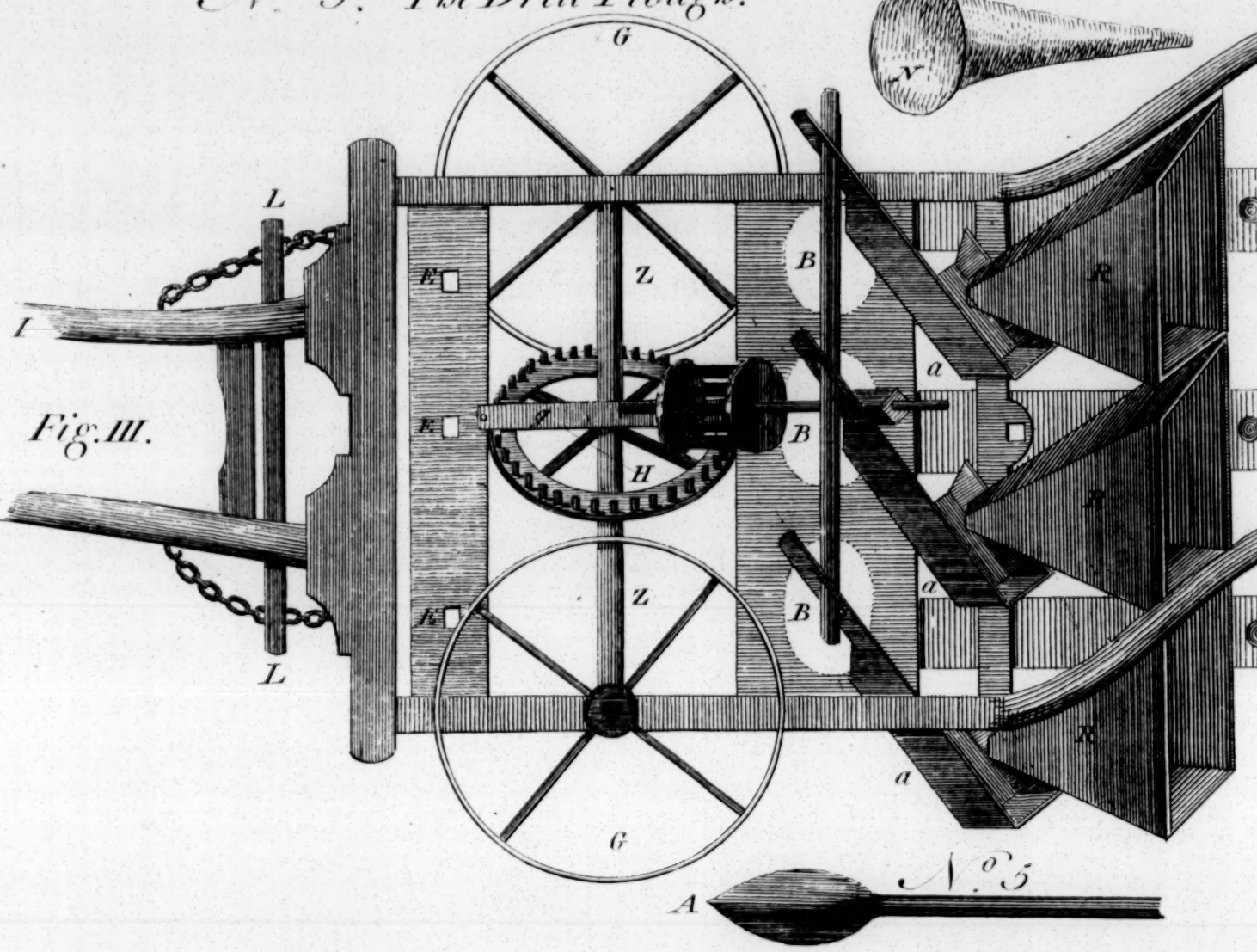

I
H
b
a
c
B
A
b
a
c
4
3
2
1
2 4 6 8 10 12
2 4 6 8 10 12
K Beilby Sculp.

Fig. II. Fine Burnet.



N.o 3. The Drill Plough.

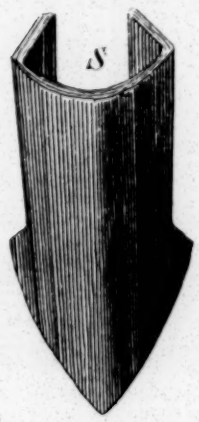


N.o 2.

N.o 5

Scale of Feet.

N.o 4.



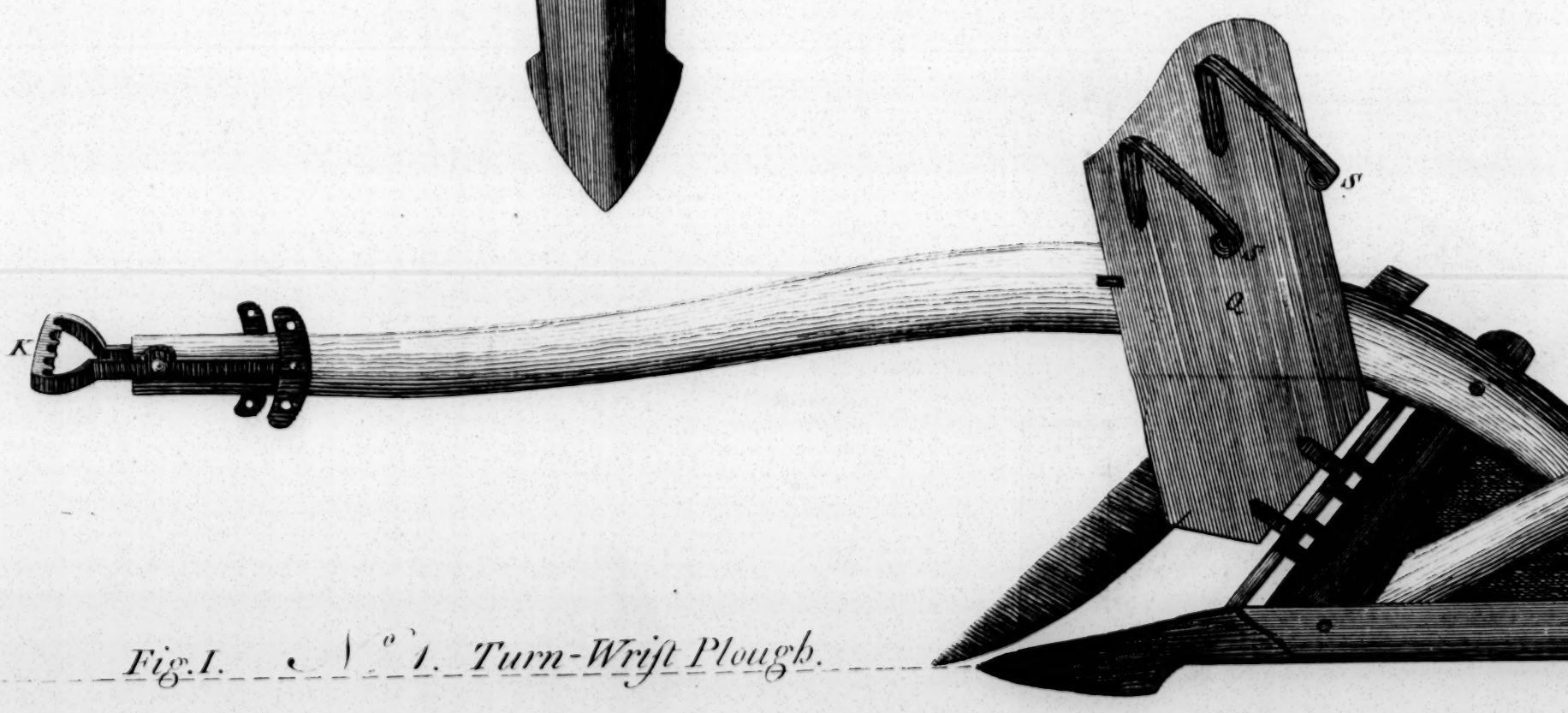
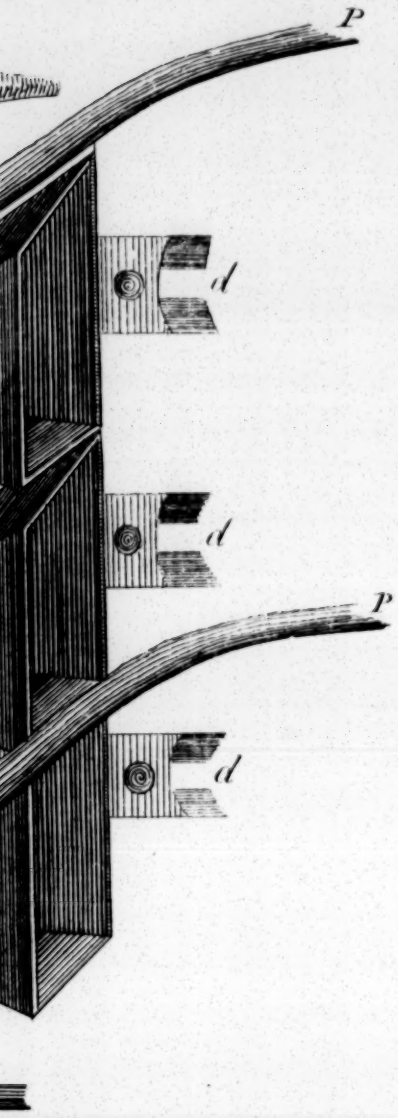


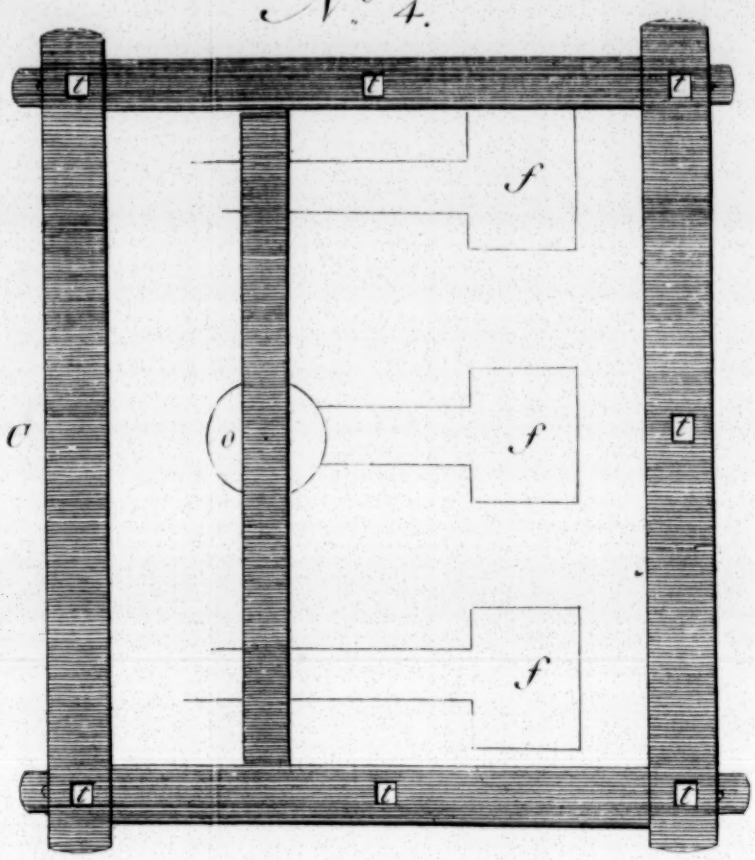
Fig. I. *N.o 1. Turn-Wrist Plough.*

Cuth.t Clark Delin.t

Plate. III.

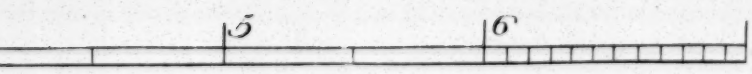


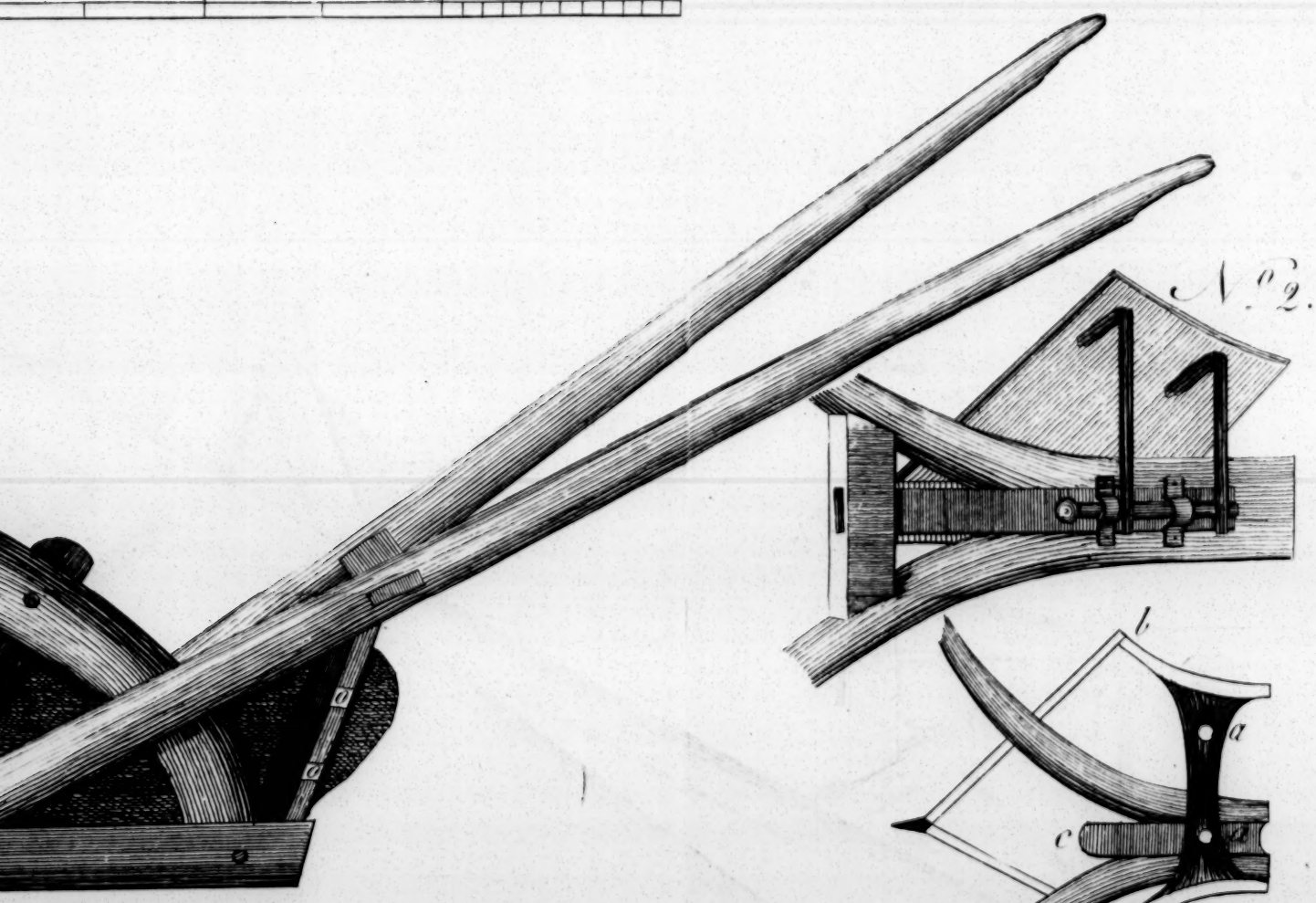
N.º 4.



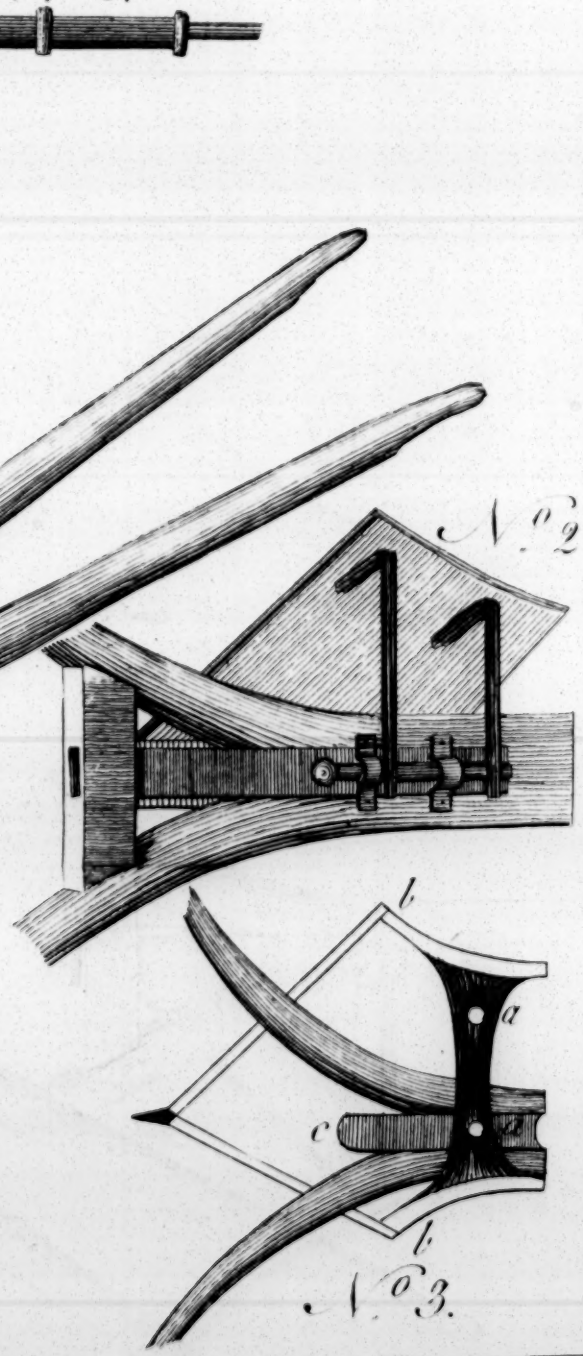
N.º 6.





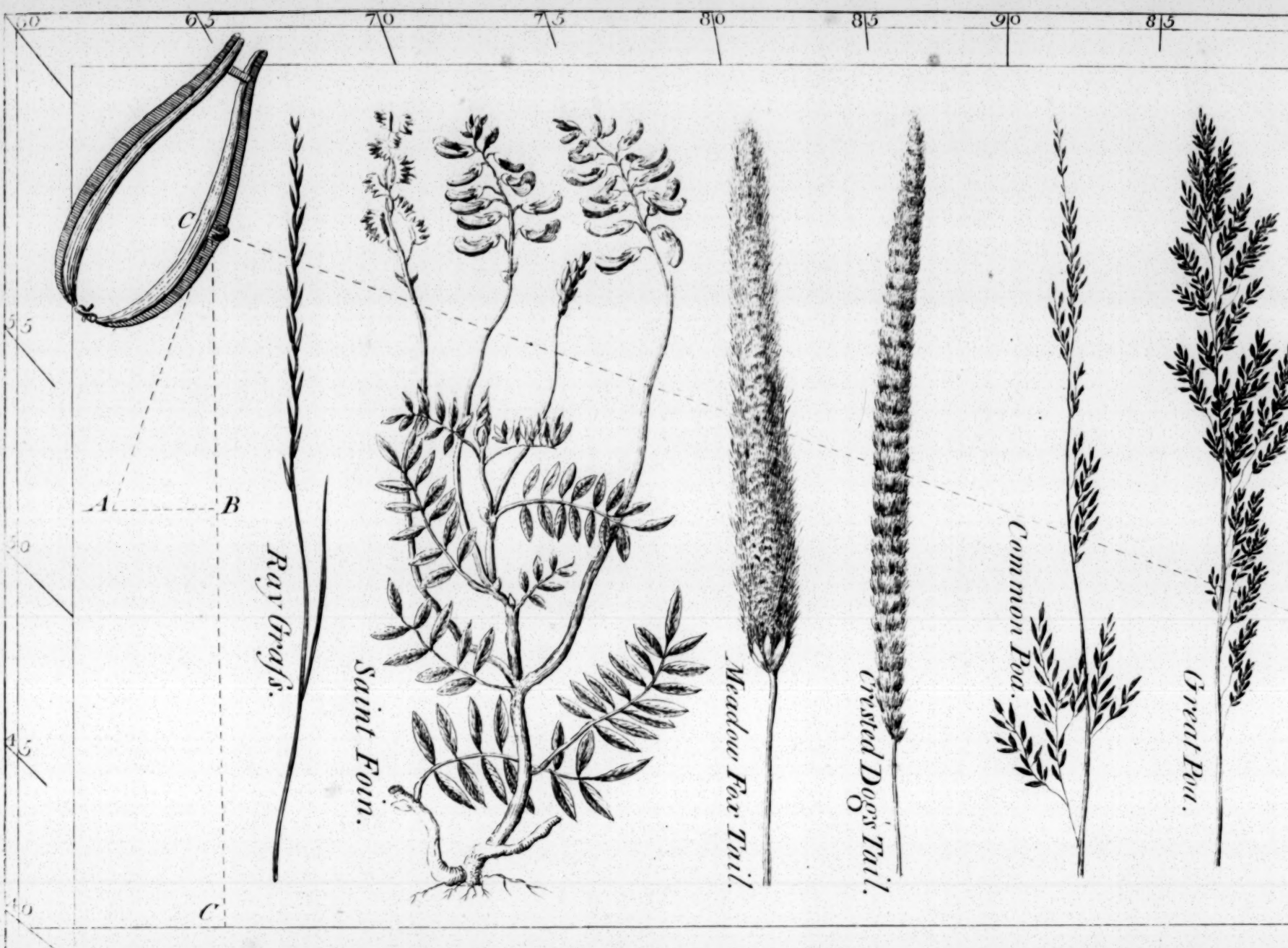


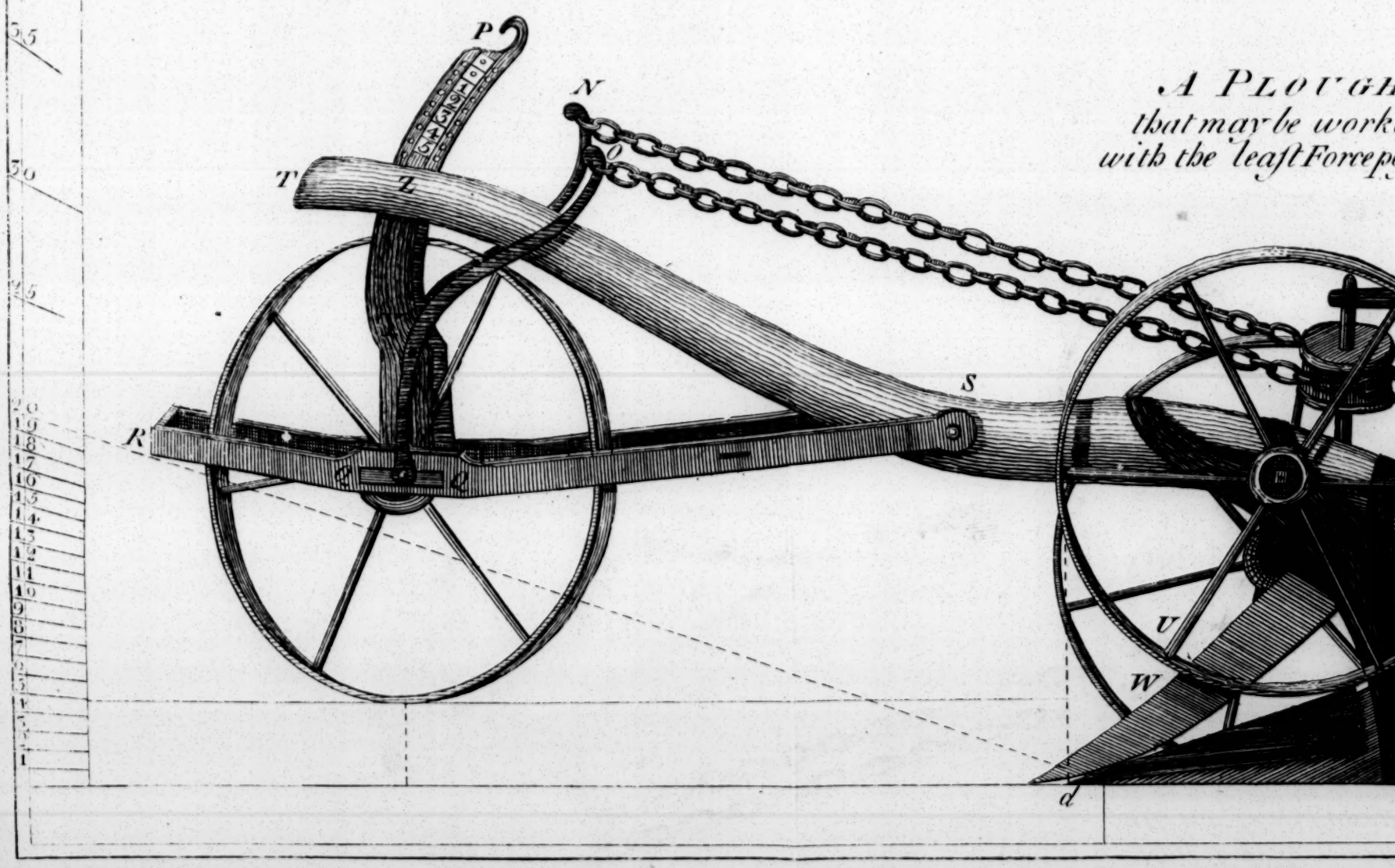
N.º 2.



N.º 3.

R. Beilby Sculp.





A PLOUGH
that may be work
with the leaſt Forces

8/0 7/5 7/0 6/5 6/0 5/5

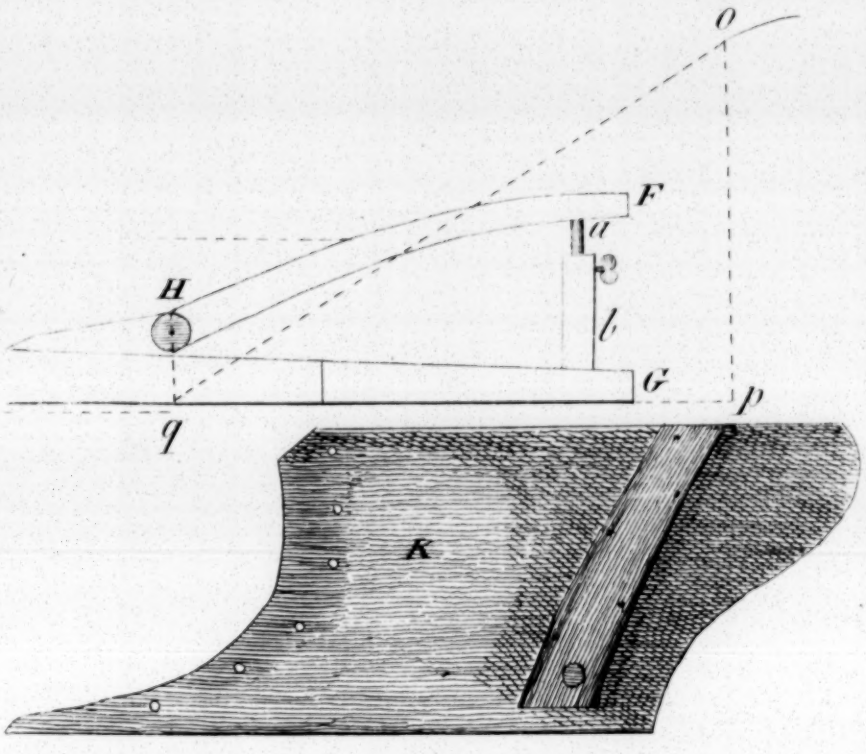
5/0 4/5 4/0 3/5 3/0 2/5 2/2 2/1 2/0 1/9 1/8 1/7 1/6 1/5 1/4 1/3 1/2 1/1 1/0 9 8 7 6 5 4 3 2 1

Great Pea.

Annual Pea.

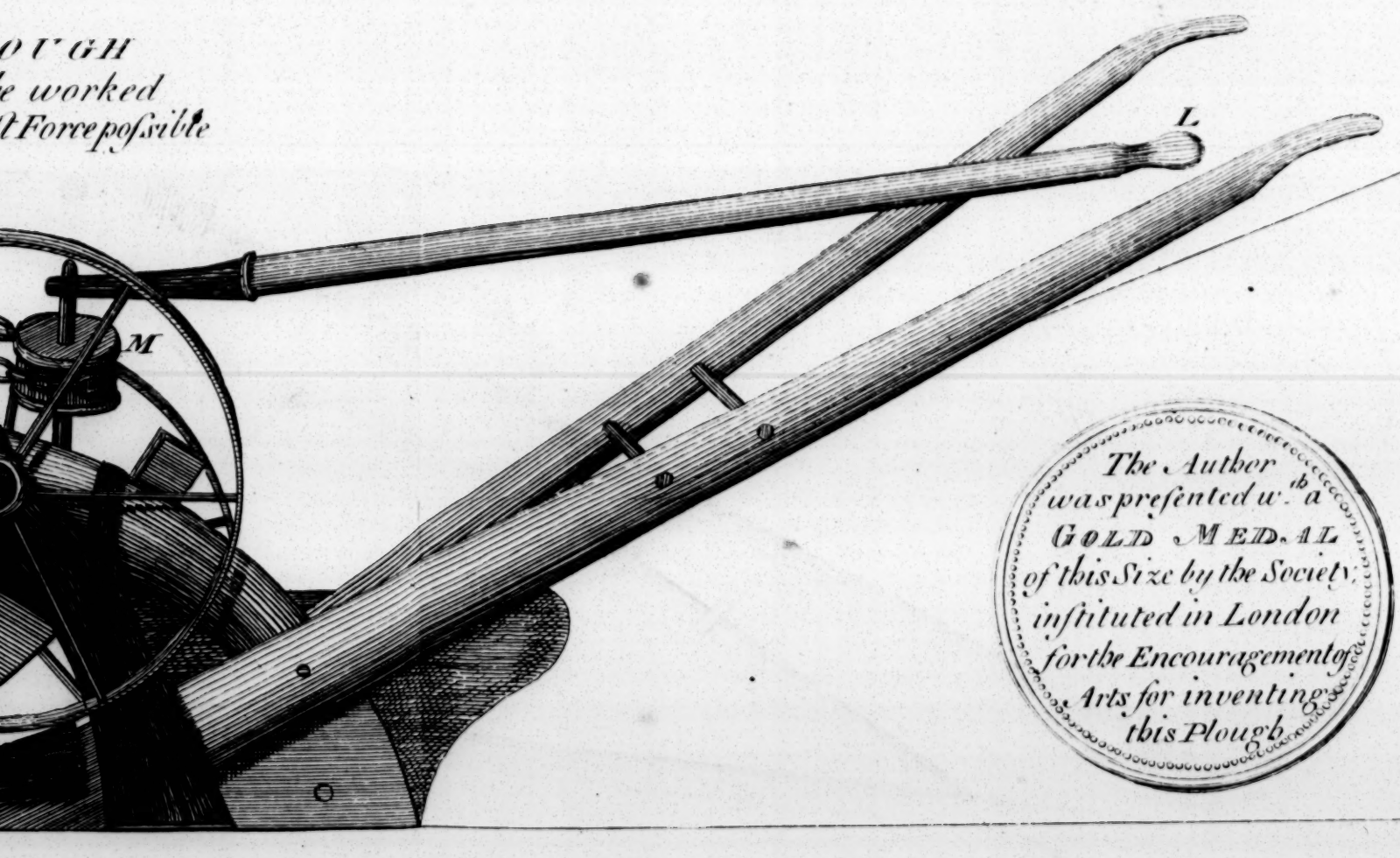
Sheep Fescue.

Meadow Fescue.





OUGH
be worked
t Force possible



The Author was presented w.th a GOLD MED.AL of this Size by the Society instituted in London for the Encouragement of Arts for inventing this Plough

R. Beilby Sculp.t

Fig. IV.

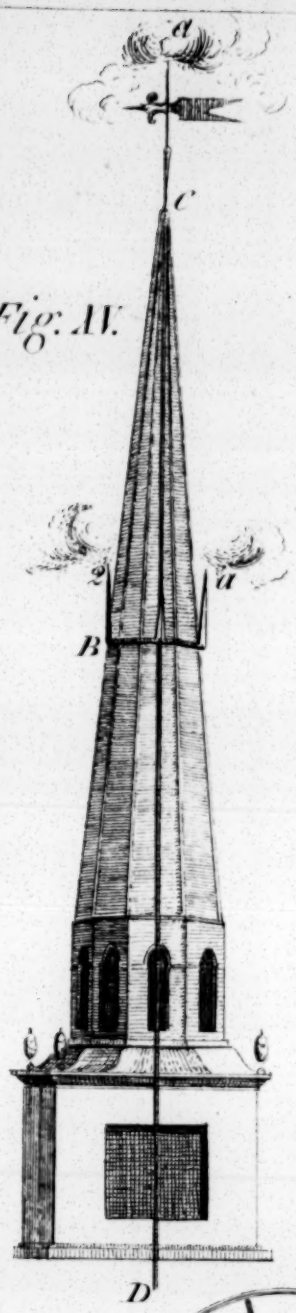


Fig. XII.

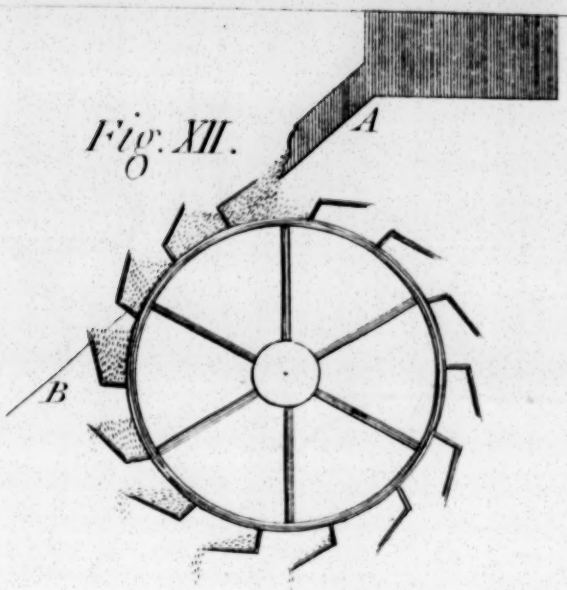


Fig. XI.

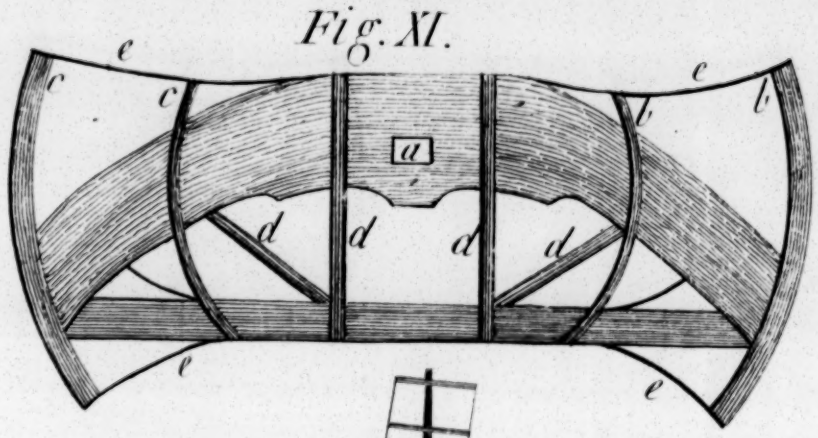


Fig. XIII.

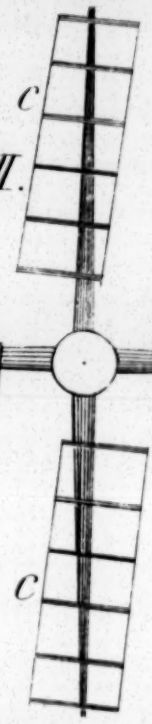
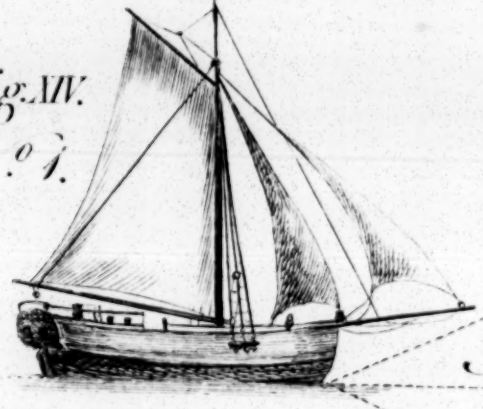


Fig. XIV.

No. 1.



No. 2.

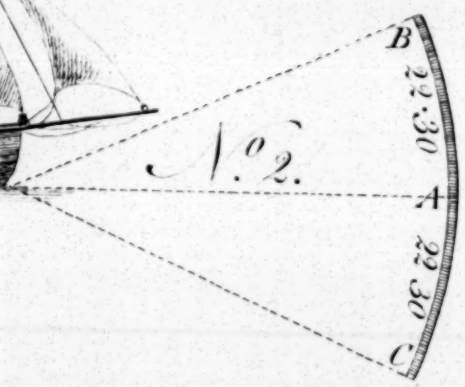


Fig. III.



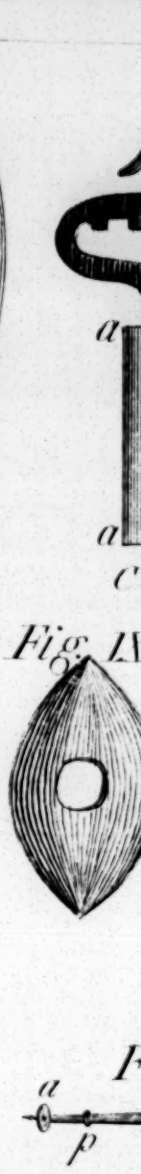
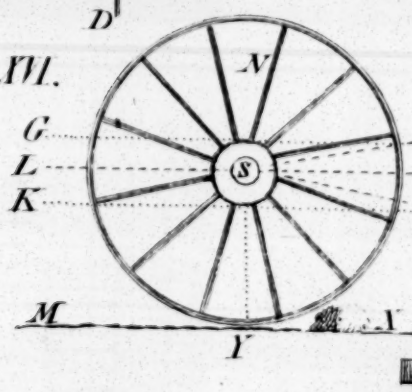


Fig. XVI.



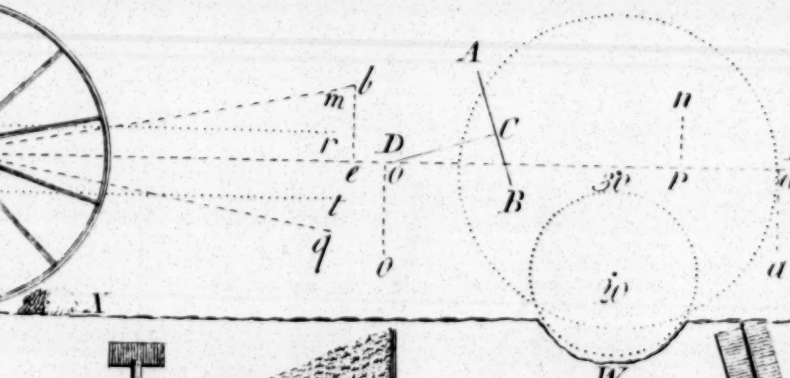
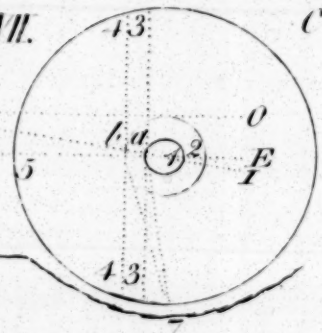


Fig. XVII.



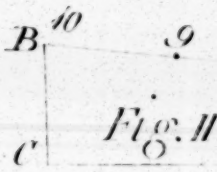


Fig. XIX.

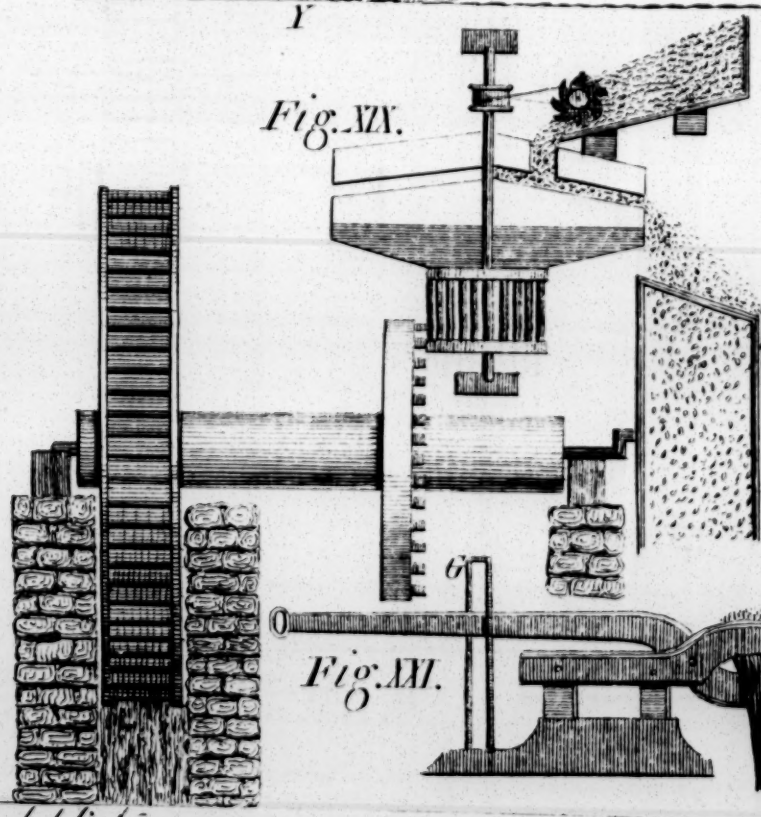


Fig. XX.

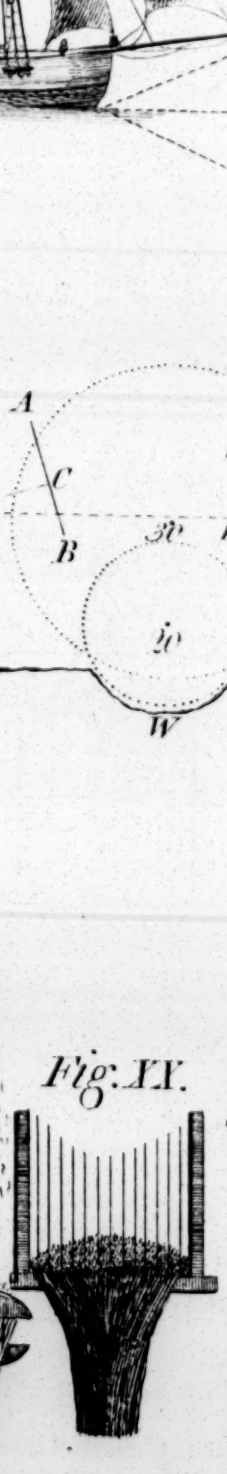
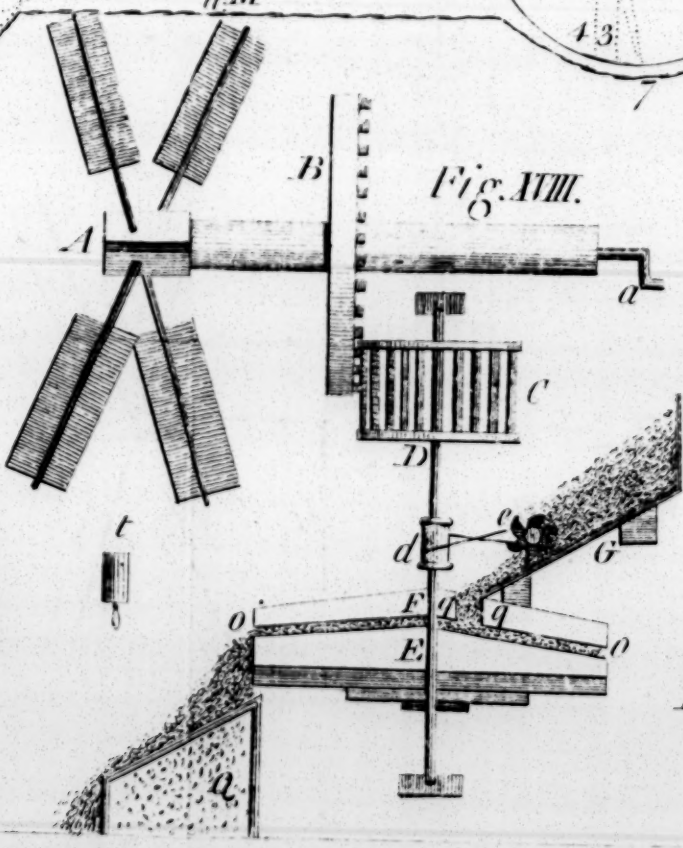


Fig. XXI.

Fig. XVIII.





P. Clark delin!

Fig. X.



Fig. IX.



Fig. VIII.



Fig. VII

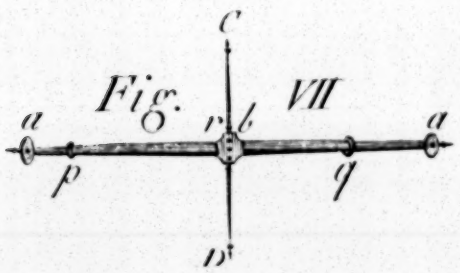


Fig. VI.

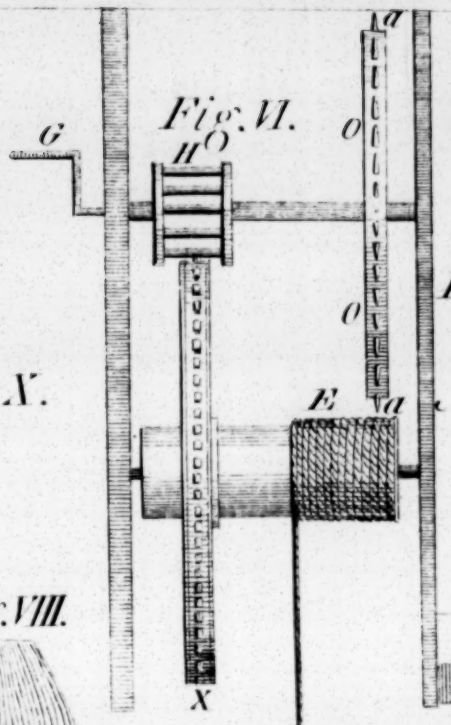


Fig. V.



N.° 2.



Fig. IV.

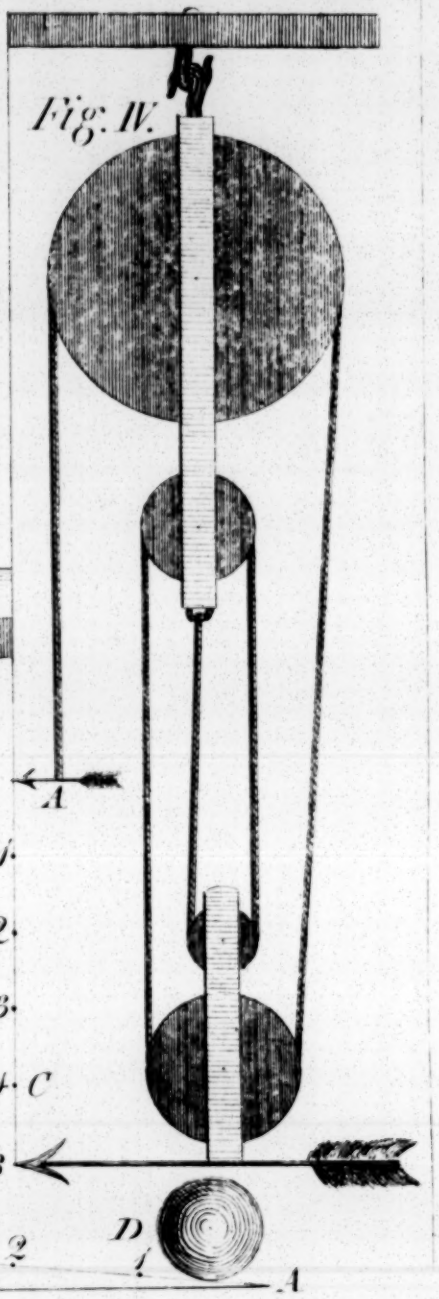
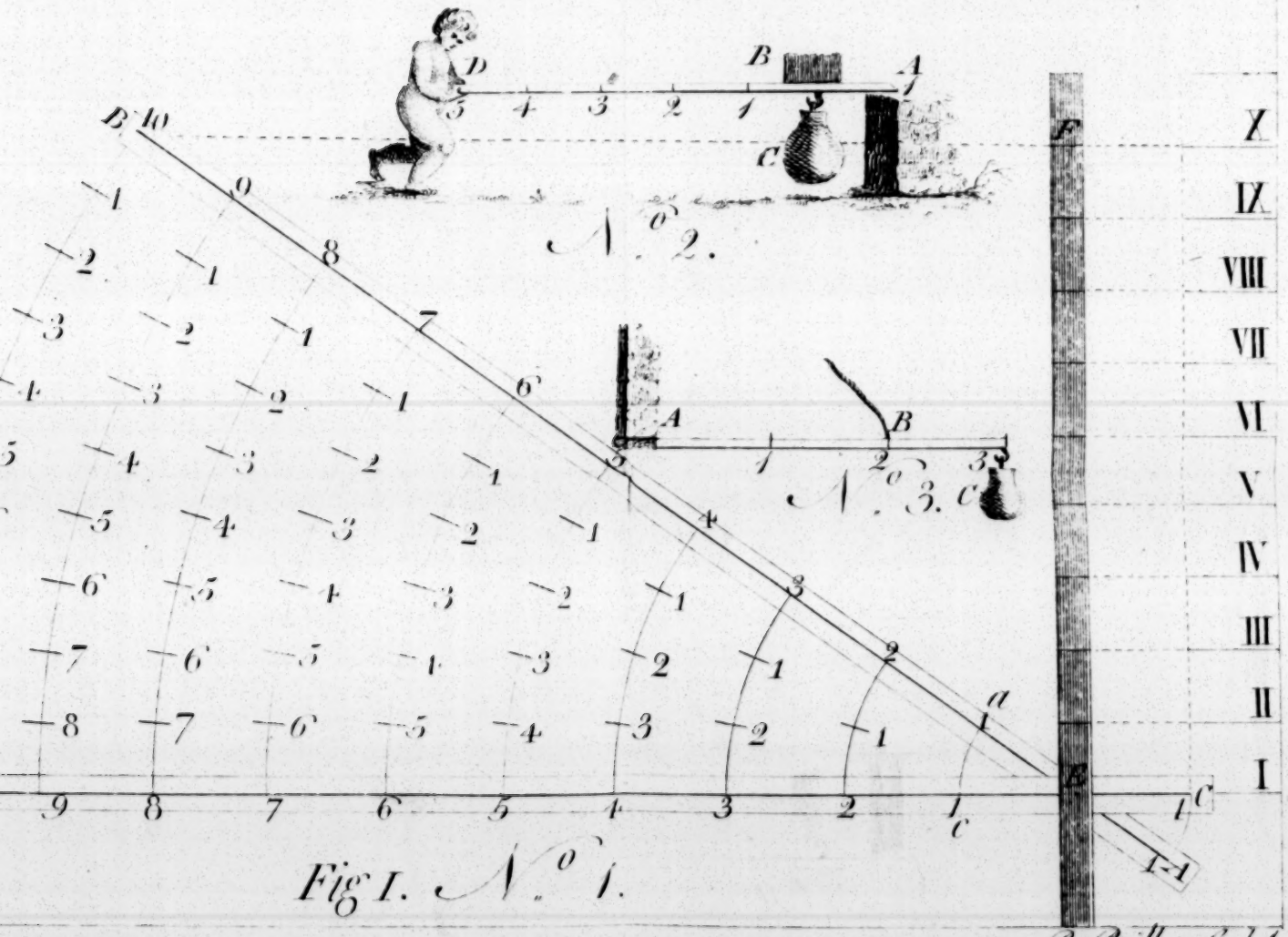


Fig. II.

N.° 2.

N.° 3.

Fig I. N.° 1.



R. Beilby Sculp.